SHORT COMMUNICATION

Clinical Risk Factors Associated With Extubation Failure in Ventilated Neonates

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We conducted this study to find out the incidence of extubation failure (EF) in ventilated neonates and associated clinical risk factors. Eighty two ventilated neonates were followed up to 48 hours post-extubation to look for EF. Twenty two babies (26.8%) had EF. The common risk factors for EF were presence of patent ductus arteriosus, post-extubation lung collapse and acquired pneumonia. The duration of ventilation, and maximum and pre-extubation alveolar arterial oxygen gradients (AaDO2) were significantly higher ($P<0.05$) in EF group. The incidence of sepsis ($P=0.034$), anemia ($P=0.004$) and pneumonia ($P=0.001$) were significantly higher in EF group. Detection of significant PDA and adequate post extubation care may help to reduce rate of extubation failure in neonates.

Key words: *Extubation failure, Newborn, Risk factors, Ventilation*.

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Weaning neonates off mechanical ventilation involves as much art as science(1). Extubation failure (EF) in neonates can occur upto one-third of cases(2). An attempt to extubate is considered a failure if there is a need for reintubation or need for accessory respiratory support within 48 hours of extubation(3). The causes of extubation failure vary from upper airway edema or stenosis to drugs, sepsis, extreme prematurity, post-extubation atelectasis and bronchopulmonary dysplasia(4,5). Usually, more than one factor is responsible for extubation failure(5). The present research was intended to document the incidence and risk factors associated with EF in ventilated neonates.

METHODS

This was a prospective observational study done in a level III neonatal unit over one year period. All inborn neonates ventilated for at least 12 hours were eligible. Neonates with major congenital malformation, HIE stage III or intraventricular hemorrhage grade 4 (USG confirmed), and babies on continuous positive airway pressure (CPAP) and nasal intermittent mandatory ventilation (NIMV) were not included. The study was approved by Institute research ethics committee and written informed consent was obtained from all parents.

All ventilated babies were monitored every hour for vitals along with continuous saturation monitoring till 48 hours post-extubation. Biochemical and blood gas monitoring was done 12-hourly. The decision of extubation was according to unit policy which were (*i*) *Clinical*: improvement in basic disease and complications managed (all hemodynamically significant PDA had ECHO done and treated); (*ii*) *Laboratory*: acceptable blood gas, packed cell volume >30%, normal blood sugars and electrolytes; (*iii*) Ventilator setting at minimum: peak inspiratory pressure of 12-14 cm of water, positive

end expiratory pressure of 3 to 3.5 cm of water, rates of 15-20/min, FiO2 0.3 to 0.25 and hemodynamically stable for 12-24 hours. Aminophylline was started pre-extubation in babies <34 weeks of gestation and steroid was used in cases of prolonged ventilation (more than 7 days). Stomach was emptied and ET suction was done just before extubation. Babies <1.5 kg were put on CPAP (4-5 cm H_2O) and babies >1.5 kg were directly extubated to head box O_2.

Extubation failure was defined as the need for reintubation or accessory respiratory support in the form of CPAP in those babies who were on head box O_2, within 48 hours of extubation. The decision of reintubation or extubation failure was taken if 2 or more of the following were present: (*i*) Increase in respiratory rate of >25% baseline; (*ii*) Increase in F_iO_2 requirement of >50% of baseline; (*iii*) Downe's score ≥6 (6); (*iv*) Silverman's score ≥7(7) and; (*v*) PaO2 <50 mm Hg, or PaCO2 >60 mm Hg.

For each episode of extubation failure, a primary, definite cause was assigned by the resident and consultant in charge who were not masked. All other contributory factors were recorded as secondary causes. Only the first episode was considered for calculating incidence in cases of repeated extubation failure. In case a child died on ventilator or left against medical advice (LAMA), he was excluded from the final analysis of incidence of extubation failure.

TABLE I DEMOGRAPHIC CHARACTERISTICS OF SUBJECTS

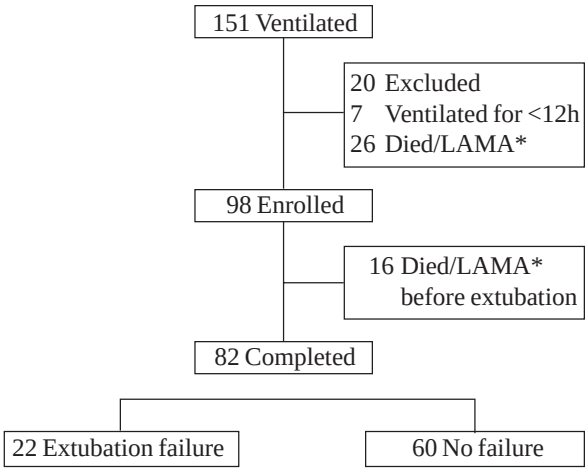
Variable	Group1 (EF) *n*=22	Group 2 (no EF) *n*=60	*P* value
Gestational age (wk)(mean ±SD)	29.9±2.4	31.05±3.6	0.291
Gestational age categories			
<28 wk	2 (9)	7 (11.6)	0.74
28 - 37 wk	19 (86.3)	46 (76.6)	0.33
≥37 wk	1 (4.7)	7 (11.8)	0.33
Birthweight (g) (mean±SD)	1402±463	1444±623	0.80
Birthweight categories			
<1 kg	4 (18.8)	12 (20)	0.85
1 to 2.499 kg	17 (77.2)	43 (71.6)	0.61
≥2.5 kg	1 (4)	5 (9.4)	0.55
Sex			
Male	17 (77.3)	50 (83.3)	0.37
Antenatal steroid received	16 (73)	39 (65)	0.51

Values are expressed as mean ± SD and n (%).

RESULTS

Enrolment is shown in ***Fig.* 1**. The demographic characteristics are given in ***Table* I** and they are similar to the babies who did not complete the study. The commonest indication of ventilation was hyaline membrane disease (40.2%) in both the groups, followed by congenital pneumonia which was significantly (*P*=0.005) more in the EF group (*n*=5, 22.7%) as compared to no EF group (*n*=2, 3.3%). Recurrent apnea was the second most common indication of ventilation in no EF (*n*=14) group as compared to none in EF group.

The incidence of extubation failure was 26.8% (*n*=22). Thirteen babies (15%) needed reintubation while 9 (10%) babies needed CPAP only. There were no differences among various weight and gestation subcategories. The three most common primary causes of extubation failure were patent ductus arteriosus (PDA), post extubation collapse and acquired pneumonia (5 each out of 22 cases). The



***** *LAMA – left against medical advice and care withdrawn*

FIG. 1 *Flowchart of total ventilated cases.*

other primary causes were apnea of prematurity, hypothermia, shock, stridor, BPD spell, premature weaning and aspiration, accounting for 1 case each.

The duration of SIMV in the extubation failure group was significantly higher in the EF group than in the no failure group (167±121 hours and 90±95 hours respectively, *P*=0.006). Maximum Alveolar-arterial oxygen gradient (AaDO2) was significantly higher (*P*=0.003) in EF group (246±150) as compared to no EF group (159±105). Pre extubation AaDO2 was also higher (*P*=<0.001) in EF group (51 ± 17) than no EF group (33±14). But a similar significant difference was not found in the initial AaDO2. Presence of prior anemia, pneumonia and sepsis significantly increased the risk of extubation failure (***Table* II**).

DISCUSSION

Extubation failure is still a common occurrence in neonatal units(3-5) and nearly one fourth of our babies had extubation failure, which is in concordance with other studies(4,8). Some authors found the association between low gestational age and low birthweight to extubation failure(4), but we did not observe this as probably we had less number of ELBW babies. Extubation failure usually indicates either incomplete resolution of underlying illness or the development of new problems. Unrecognized patent ductus arteriosus (which can be missed clinically in upto 50% cases) and fluid overload can contribute significantly to the incidence of extubation failure and their signs can be masked in a ventilated neonate, until the end expiratory pressure is removed and hence many PDA may remain silent(5), which probably happened in our cases. Five cases of EF were attributed to post extubation collapse. Use of CPAP, adequate humidification and physiotherapy have been proposed to decrease the incidence of post extubation collapse(9-11). Acquired pneumonia accounted for a significant number of EF probably related to high number of sepsis in our unit. Prolonged duration of ventilation has been quoted as a risk factor of extubation failure(12-14) and we also found the similar trend, probably suggesting the fact that these babies had severe lung disease needed longer duration of ventilation. The maximum as well as the pre-extubation AaDO2 were significantly higher in the EF group, suggesting that these neonates had a significant lung disease leading to a higher chance of extubation failure.

Babies who had anemia any time during their course also had a higher risk of extubation failure which is in concordance with other studies(15). We also found an association between pre-existing pneumonia and sepsis, and extubation failure, which probably are related to sickness of the baby and requiring prolonged ventilation in pneumonia cases. The strength of our study is a large sample size and meticulous study protocol, which was followed strictly, but the limitations are small number of ELBW babies in whom chances of extubation failures are higher. We also did not attempt NIMV before reintubating them. Future trials should include larger no of ELBW babies and trying NIMV for extubation failure cases.

Contributors: GMH and KM conceived the idea and GMH, KM, AN designed the study. GMH collected the data. GMH and KM analysed the data, drafted the paper. AN helped in critical review of manuscript.

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TABLE II RISK FACTORS IN NEONATES WITH EXTUBATION FAILURE

Risk Factor	EF group (*n*=22)	No EF group (*n*=60)	*P* value	Relative risk	95% Confidence Interval
Anemia	11 (50%)	11 (18%)	0.004	2.7	1.38 to 5.37
Pneumonia	12 (54%)	10 (16%)	0.001	3.27	1.65 to 6.48
Sepsis	9 (42%)	11 (18%)	0.034	2.23	1.07 - 4.64

WHAT THIS STUDY ADDS?

- Patent ductus arteriosus, post extubation lung collapse and acquired pneumonia are associated with extubation failure in neonates.

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