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Success rate and neonatal morbidities associated with early extubation in extremely low birth weight infants

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Go to:

Abstract

BACKGROUND AND OBJECTIVES:

Mechanical ventilation improves survival of preterm infants with respiratory failure. The aim of this study was to determine the success rate and short-term neonatal morbidities of early extubation in extremely low birth weight (ELBW) infants in a tertiary care neonatal intensive care unit (NICU).

DESIGN AND SETTING:

Retrospective cohort study of ELBW infants admitted to a tertiary. neonatal intensive care referral unit from January 1st to December 31st, 2005.

PATIENTS AND METHODS:

The primary outcome was the success rate of early extubation in ELBW infants who were intubated at delivery, extubated in the first 48 hours of life, and did not require reintubation within 72 hours following extubation.

RESULTS:

Thirty of the 95 eligible infants were extubated early; of these 30 infants, 24 (80%) had a successful extubation. Infants extubated early had a higher mean birth weight (855 vs 745 g; $P<.0001$) and gestational age (27.3 vs 25.6 weeks; $P<.0001$). ELBW infants who were extubated early had lower rates of death (relative risk [RR], 0.05; 95% CI, (0.0, 0.79); $P=.003$), intraventricular hemorrhage (IVH) (RR, 0.23; 95% CI, 0.08, 0.70; $P=.008$), and patent ductus arteriosus (PDA) (RR, 0.76; 95% CI, 0.60, 0.98; $P=.03$) compared with those who remained ventilated beyond the first 48 hours of life.

CONCLUSION:

The rate of successful early extubation in our unit exceeded the sole previously reported rate. Successful early extubation was associated with lower rates of death, IVH, and PDA in ELBW infants.

Mechanical ventilation improves survival of preterm infants with respiratory failure. However, prolonged mechanical ventilation in extremely low birth weight (ELBW) infants increases the risk of serious complications, including bronchopulmonary dysplasia (BPD),[1] subglottic stenosis,[2,3] infection, and mortality.[4]

Continuous positive airway pressure (CPAP) was first used as a method of respiratory support for preterm infants in 1971.[5] Since then, our knowledge has advanced regarding the physiological and clinical effects of CPAP,[6] including improved oxygenation, maintenance of lung volume,[7–10] lowering upper airway resistance,[11,12] and reduction of obstructive apnea.[13] The lack of one or all of these factors is the main reason for extubation failure in ELBW infants.

Nasal CPAP (NCPAP) is now widely used for a range of neonatal respiratory conditions. The use of NCPAP in the respiratory management of ELBW infants has increased 4-fold in Australia and New Zealand.[14] It has been established as an effective method of preventing extubation failure[15] and is increasingly recognized as an alternative to intubation and ventilation for the treatment of respiratory distress syndrome.

Beyond the emergence of encouraging NCPAP data from Columbia University (New York, NY),[16] a trend toward increased use of an early extubation strategy (extubation within the first 48 hours of life) was noted in the neonatal intensive care unit (NICU) at the McMaster Children's Hospital. The success rate of this strategy and its efficacy in reducing important short-term adverse outcomes and possible adverse events in case of its failure were unknown.

Our objective was to determine the success rate and short-term neonatal morbidities of early extubation (within the first 48 hours of life) in ELBW infants in a tertiary care NICU.

Go to:

PATIENTS AND METHODS

A retrospective cohort study of all ELBW infants admitted to NICU at the McMaster Children's Hospital in 2005 was conducted. The study was approved by the McMaster University Research Ethics Board (REB).

ELBW infants (those born at the McMaster Children's Hospital and those born elsewhere) who were intubated at delivery were included. ELBW infants who were intubated at delivery, extubated in the first 48 hours of life, and did not require reintubation within 72 hours[17] following extubation were considered as our index patients (early extubation); controls included all enrolled ELBW infants not fulfilling these criteria. The primary outcome was the success rate of early extubation in the index patients. Secondary outcomes included mortality and important short-term neonatal morbidities such as patent ductus arteriosus (PDA), diagnosed by echocardiography when clinically indicated; pulmonary hemorrhage (diagnosed by suctioning of blood from the endotracheal tube, associated with increased ventilatory/oxygen support or need for blood transfusion); intraventricular hemorrhage (all grades); stages II-III necrotizing enterocolitis (NEC) as per Bell's classification; and retinopathy of prematurity (ROP) diagnosed by ophthalmologic findings, according to the International Classification of Retinopathy of Prematurity.[18] BPD rates were not included since our infants were transferred to community hospitals prior to 36 weeks corrected age. Of note, all ELBW infants extubated in our unit were managed noninvasively with NCPAP and were weaned gradually off NCPAP based on their respiratory effort, oxygen requirements, and blood gas results.

Descriptive summaries of demographic and clinical characteristics were generated with respect to all participants at baseline. Continuous data were summarized using medians, interquartile ranges (Q1, Q3), and means and standard deviation for normally distributed data. Differences between groups were evaluated using the Student *t* test for means, and Mann-Whitney U test for group medians. The chi-square and the Fisher exact tests, where appropriate, were applied for binary outcomes. Two-sided 95% confidence intervals (CIs) and *P* values are reported. Data were analyzed using the statistical package SPSS 13.0 for Windows (SPSS Inc., Chicago, Ill).

Go to:

RESULTS

In the study period, 95 ELBW infants were found eligible (Figure 1). Nine infants were excluded from the study as they were not intubated in the delivery room during the study period. Thirty (32%) of all eligible infants were extubated early; of these, 24 (80%) had a successful extubation. Infants extubated early had a higher mean birth weight (855 vs 745 g; $P<.0001$) and gestational age (27.3 vs 25.6 weeks; $P<.0001$) and were more likely to be delivered vaginally compared with the control group (Table 1). Other baseline characteristics were comparable in both the study groups.

ELBW infants who were extubated early had lower rates of death (relative risk [RR], 0.05; 95% CI, 0.0, 0.79; $P=.003$), intraventricular hemorrhage (IVH) (RR, 0.23; 95% CI, 0.08, 0.70; $P=.008$), and PDA (RR, 0.76; 95% CI, 0.60, 0.98; P=.03) compared with those who remained ventilated after 48 hours. There was no statistical difference between both groups with regard to rates of PDA ligation, pneumothorax, pulmonary hemorrhage, stages II-III NEC, post-IVH hydrocephalus, and ROP (Table 2).

Go to:

DISCUSSION

Preterm infants may experience postextubation difficulty with spontaneous, unsupported breathing for a variety of reasons, including lung immaturity, chest wall instability, and upper airway obstruction combined with poor central respiratory drive.[17]

Our data support our adopted strategy of early extubation of ELBW infants (in the first 48 hours of life), with a success rate that exceeds the sole reported rate,[19] in addition to a reduction in important intermediate adverse neonatal outcomes, including death, IVH, and PDA, without increased adverse outcome in those infants who failed extubation. This is the first study to report a success rate of early extubation (in the first 48 hours of life), in ELBW infants.

When mechanical ventilation cannot be avoided in the management of ELBW infants, early weaning of the ventilator to NCPAP should be the aim. The use of NCPAP after extubation was assessed in 7 trials that enrolled 479 infants. The number needed to treat (NNT) for prevention of extubation failure is 6 (95% CI, 4-11). When subgroups were assessed, it appeared that NCPAP was successful when used within 14 days of birth with a pressure of 5 cm H_2O or more. The addition of methylxanthines is even more effective, with an NNT of 2.[20]

Although it is quite difficult to predict the chances of success for each infant prior to extubation, our data showed that successfully extubated infants had a higher birth weight and gestational age and were more likely to be delivered by the vaginal route. The fact that premature infants born via the vaginal route had a higher chance of successful extubation could be explained by a more favorable lung status relative to endogenous steroid production, antenatal stability prior to delivery, or occurrence simply by chance.[21–24]

Our study is limited by its retrospective nature and the small sample size, which weakens our ability to determine the safety of this approach, especially in infants who fail an extubation attempt.

In conclusion, the rate of successful early extubation in our unit was higher than the previously reported incidence. Successful early extubation was associated with lower rates of death, IVH, and PDA in ELBW infants. Larger randomized controlled trials are required to assess the safety of this approach.

Go to:

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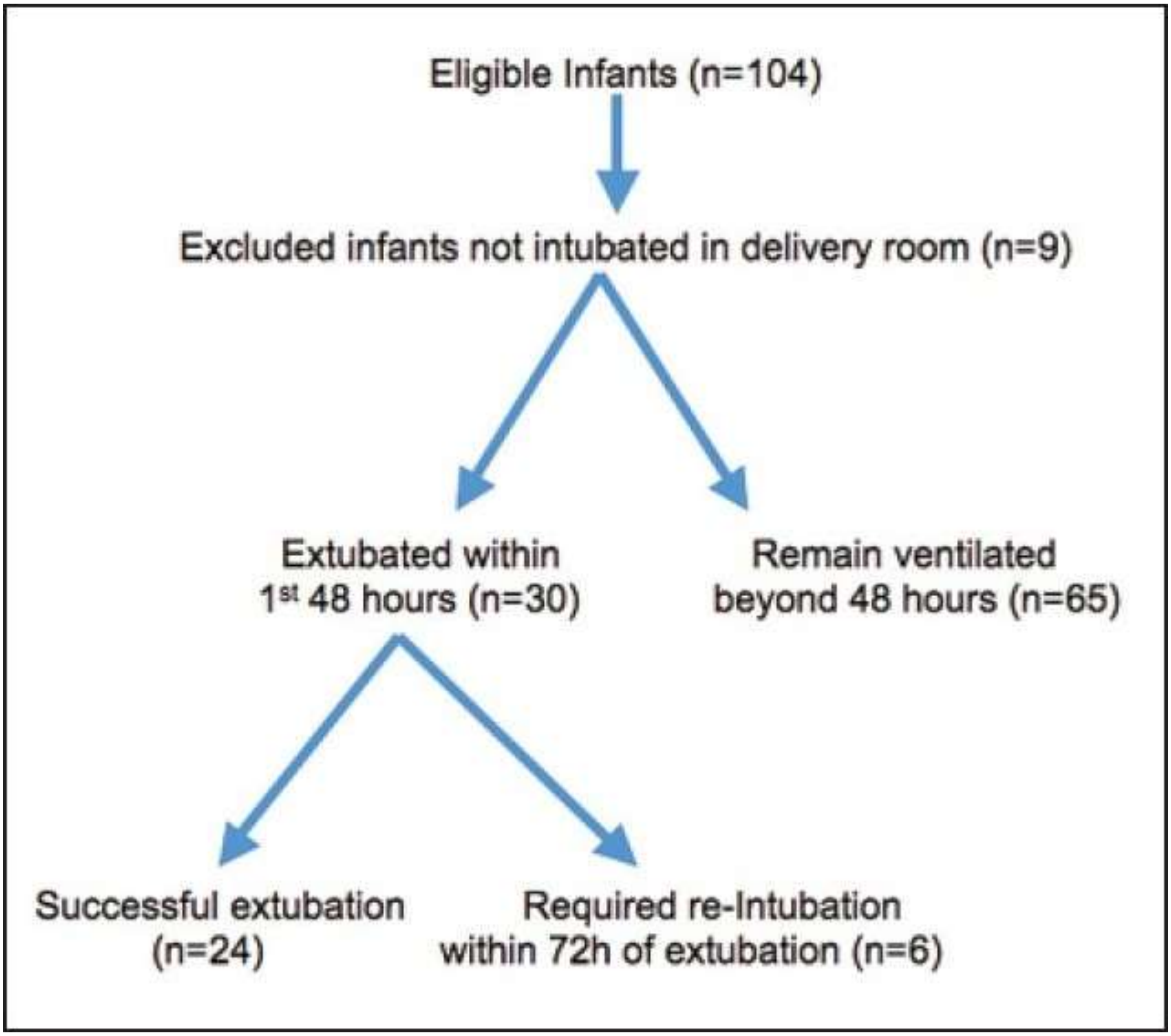
Go to:

Figures and Tables

Figure 1



Flow chart of patient assignment in the study.

Table 1

Variables	Early extubation (n=30)	Control (n=65)	*P* value
Birth weight (g)*	855 (113)	745 (138)	<.0001
Gestational age (wk)*	27.3 (1.7)	25.6 (1.95)	<.0001
Male (number [%])	14 (47)	39 (60)	NS
Prolonged ROM (number [%])	8 (27)	20 (32)	NS
Antenatal steroids (number [%])	24/26 (93)	51/56 (92)	NS
Vaginal delivery (number [%])	23 (77)	33 (49)	.03
Chorioamnionitis (number [%])	7 (23)	17/58 (29)	NS

*Shown are mean (SD). NS: not significant, ROM: rupture of membranes

Baseline characteristics of enrolled infants

Table 2

Outcomes	Early extubation (n=30)	Control (n=65)	RR (95% CI)	*P* value
Death in NICU	0	16	0.05 (0.0, 0.79)	.003
Pneumothorax	0	8	0.13 (0.01, 2.1)	NS
Pulmonary hemorrhage	0	8	0.13 (0.01, 2.1)	NS
PDA	21/30	55/60	0.76 (0.60, 0.98)	.03
PDA ligation	4	17	0.51 (0.19, 1.4)	NS
IVH	3	28/62	0.23 (0.08, 0.7)	.008
Post-IVH hydrocephalus	2	12/62	0.34 (0.08. 1.44)	NS
PVL	9	21/62	0.9 (0.46, 1.69)	NS
NEC stages II-III	3/29	9/64	0.74 (0.22, 2.52)	NS
ROP	15/22	32/39	0.83 (0.6, 1.15)	NS

RR: relative risk, CI: confidence interval, NICU: neonatal intensive care unit, PDA: patent ductus arteriosus, IVH: intraventricular hemorrhage, NEC: necrotizing enterocolitis, ROP: retinopathy of prematurity, PVL: periventricular leukomalacia

Short-term neonatal outcomes