Comparative study between Invasive and Non-invasive Mechanical ventilation in treatment of Respiratory Distress Syndrome in preterm infant

Osama A. El Fiki, Yasser M, Ismail, Effat H, Assar, Hassan F, Hassan

Department of pediatrics, faculty of medicine, Benha University, Egypt
Telephone: +21003186726, E-mail: drhassan949@gmail.com

Abstract: Respiratory distress syndrome (RDS) is a condition of respiratory distress which commences at or shortly after birth and increases in severity over the first three days of life, and it also is the most common cause of morbidity and mortality in preterm infants and is related inversely to the gestational age. [(1)] Endotracheal ventilation is related to increasing risks of infection and ventilation-associated lung injuries. Importantly, prolonged duration of endotracheal ventilation induces a higher probability of death or survival with neurologic impairment and/or broncho-pulmonary dysplasia (BPD) in the post neonatal period. Thus there is a trend to minimize the use of mechanical ventilation. [(2)] Non-invasive ventilation (NIV) has gained increased popularity in the neonatal intensive care unit (NICU) With the increased survival of extreme low gestational age neonates (ELGAN) < 28 week´s non-intubated. The primary aim of NIV is to provide respiratory support without the pulmonary and non-pulmonary complications associated with intubation and mechanical ventilation. [(3)] the aim of this work is to compare between effectiveness of invasive mechanical ventilation and non-invasive mechanical ventilation as the first line treatment of respiratory distress syndrome to evaluate their impact on neonatal mortality and morbidity. This was a prospective study conducted over a period of six months from February 2018 to August 2018 including 60 infants suffering from RDS admitted in neonatal care unit (NICU) in Benha University Hospitals and Benha children hospital. A total number of 60 neonates suffering from respiratory distress syndrome were admitted to the NICU. We found no significant difference between invasive and Non-invasive mechanichal ventilation groups in success or mortality rates, (the duration of ventilation) was longer in Non-invasive groups (sepsis and pneumothorax) was higher in invasive group and (apnea, nasal trauma) was higher in Non-invasive group. It appears that HHHFNC is a good alternative to invasive mechanical ventilation in premature newborns with respiratory failure. Anyway some infants did not respond to this mode of respiratory support and require mechanical ventilation.
[Osama A. El Fiki, Yasser M, Ismail, Effat H, Assar, Hassan F, Hassan. **Comparative study between Invasive and Non-invasive Mechanical ventilation in treatment of Respiratory Distress Syndrome in preterm infant.** *Biomedicine and Nursing* 2018;4(4): 15-19]. ISSN 2379-8211 (print); ISSN 2379-8203 (online). http://www.nbmedicine.org. 4. doi:10.7537/marsbnj040418.04.

Keywords: respiratory distress syndrome, High flow nasal cannula.

1. Introduction

Respiratory distress syndrome (RDS) is a condition of respiratory distress which commences at or shortly after birth and increases in severity over the first three days of life, and it also is the most common cause of morbidity and mortality in preterm infants and is related inversely to the gestational age. [(1)] Endotracheal ventilation is related to increasing risks of infection and ventilation-associated lung injuries. Importantly, prolonged duration of endotracheal ventilation induces a higher probability of death or survival with neurologic impairment and/or broncho-pulmonary dysplasia (BPD) in the post neonatal period. Thus there is a trend to minimize the use of mechanical ventilation. [(2)] Non-invasive ventilation (NIV) has gained increased popularity in the neonatal intensive care unit (NICU) With the increased survival of extreme low gestational age neonates (ELGAN) < 28 week´s non-intubated,. The primary aim of NIV is to provide respiratory support without the pulmonary and non-pulmonary complications associated with intubation and mechanical ventilation. [(3)]

Non-invasive ventilation (NIV) has gained increased popularity in the neonatal intensive care unit (NICU) With the increased survival of extreme low gestational age neonates (ELGAN) < 28 week´s non-intubated,. The primary aim of NIV is to provide respiratory support without the pulmonary and non-pulmonary complications associated with intubation and mechanical ventilation. [(3)]

There are a number of ways NIV can be applied, including nasal continuous positive airway pressure (NCPAP), nasal intermittent positive pressure ventilation (NIPPV), nasal high frequency oscillatory ventilation (NHFOV) and humidified high flow nasal

cannula (HFNC). [3] The use of NIV in neonates is not a completely new concept and has been in use for almost over half century. [5] The first report on possible use of NIV in neonates was published about 20 years before the Gregory's paper in 1971 on continuous positive airway pressure CPAP. [6]NIV was found to achieve better gaseous exchange than simple oxygen therapy but was shown to be associated with significant head molding and cerebral hemorrhage due to the use of face mask straps. [7] Similarly, the reports of gastric perforations with use of non-invasive ventilation made neonatologists reluctant to use NIV. [8] With the advent of newer interfaces and devices, these complications are now less common, [9] [10] and the clinicians are once again more interested in exploring the new ways of providing NIV as highlighted by recent surveys. [11] [12].

Various modes and ways of delivering NIV (synchronous or asynchronous) are being tested, and one can hope that this will further improve our understanding of use of NIV in preterm babies. [13]

2. Material and Methods:

This was a prospective, randomized, unblinded clinical study that was approved from ethics committee of faculty of medicine, Benha University. The study was performed at Benha University Hospital and Benha children hospital, in the period between February 2018 and August 2018.

Inclusion criteria:

The birth weight was more than 1000 grams and gestational age was more than 28 weeks and less than 32 weeks, Age from 0 to 7 days of life, If the infant had the aforementioned criteria, he was eligible for the trial.

Exclusion criteria:

Birth weight < 1000 grams, Gestational age < 28 weeks or > 32 weeks, Presence of air leak, Congenital anomalies of the air passages like (Pierre-Robin, choanal atresia, cleft lip, or cleft palate), Major abdominal, cardiac, or respiratory deformities, Demographic data including (birth weight, GA, antenatal steroid use and postnatal age at the time of the entrance to the study, were recorded by one of the investigators), We also assessed the incidence of complications such as pneumothorax, BPD, necrotizing enterocolitis (NEC) and cranial ultrasonography for evaluation of IVH was performed on the 3 and 7 days after birth in the two groups. In addition to apnea of prematurity and apnea due to other causes were recorded. Duration of oxygen therapy, length of hospital stay, and duration of respiratory support were recorded.

Primary Outcome

•It was determined by the need for mechanical ventilation in the initial 72 hours from the start of respiratory supportive mode.

•The following are criteria of non-invasive respiratory support failure Apnoea in spite of despite 30 seconds of positive pressure ventilation.

Heart rate less than 100 beats\ minute without increase in spite of 30 seconds of positive pressure ventilation, FIo2 more than 60% to keep Sa O2 more than 88%, Recurrent or significant Apnoea and bradycardia more than one episode every 12-hour duration that needs PPV, Sustained severe retraction, Suspicion of air passages obstruction in spite of adequate suction, Cardiovascular failure i.e. Heart rate less than 60 beats \ minute or shock, 7. Marked metabolic acidosis i.e. Arterial base deficit more than -10, Severe respiratory acidosis i.e. Arterial PCo2 more than 60 H2O.

Secondary Outcomes:

Total days of respiratory support including ventilation and oxygen supply, Requirement of intubation beyond the initial 72 hours from the intervention, Occurrence of complication such as Apnoea, pneumothorax, Necrotizing enterocolitis, sepsis and retinopathy of prematurity, Evaluation of nasal mucosal injury, The incidence of bronchopulmonary dysplasia (BPD).

Statistical Methods:

Data management and statistical analysis were done using SPSS v.25. Numerical data was summarized as means and standard deviations. Categorical data was summarized as numbers and percentages. Comparisons between two groups were done using Independent t test or Mann Whitney U test for normally and non-normally distributed numerical variables respectively. Categorical variables were compared using Chi-square test of Fisher's exact test if appropriate. All P values were two sided. P values less than 0.05 were considered significant.

3. Results:

The results are shown in Tables 1-4.

Table (1): Demographic, clinical and baseline characteristics of included neonates.

		Non-invasive (n = 30)	Invasive (n = 30)	P value
Gestational age (weeks)	Mean ±SD	30 ±1	30 ±1	1.0
Gender	Males n (%)	16 (53.3)	20 (66.7)	0.292
	Females n (%)	14 (46.7)	10 (33.3)	
Mode of delivery	CS n (%)	28 (93.3)	28 (93.3)	1.0
	Vaginal n (%)	2 (2.7)	2 (6.7)	
Birth weight (Kg)	Mean ±SD	1.867 ±0.16	1.897 ±0.26	0.585
Maternal age	Mean ±SD	23 ±6	22 ±6	0.305
Gravidity	Mean ±SD	2 ±1	2 ±1	0.093
Antenatal steroid	Yes n (%)	18 (60.0)	18 (60.0)	1.0
Pre-study surfactant	Yes n (%)	8 (26.7)	10 (33.3)	0.573
Down's score	Mean ±SD	7 ±1	7 ±1	0.326

Table (2): Success and mortality in infants included in the study.

	Non-invasive (n = 30)		Invasive (n = 30)		
	N	**%**	**N**	**%**	**P value**
Success	22	73.3	20	66.7	0.573
Mortality	6	20.0	8	26.7	0.542

Table (3): Respiratory support outcomes in the studied infants.

	Non-invasive (n = 30)		Invasive (n = 30)		
	Mean	**±SD**	**Mean**	**±SD**	**P value**
Duration of ventilation (days)	8	3	7	2	0.03
Duration of oxygen supply (days)	10	3	8	2	0.01

Table (4): Reported secondary outcomes in the studied groups.

	Non-invasive (n = 30)		Invasive (n = 30)		
	N	**%**	**N**	**%**	**P value**
Sepsis	7	23.3	15	50.0	0.032
Abdominal distension	12	40.0	8	26.7	0.273
Nasal trauma	6	20.0	0	0.0	0.024
Pneumothorax	0	0.0	7	23.3	0.011
Apnea	6	20.0	0	0.0	0.024
ROP	0	0.0	0	0.0	-

4. Discussions

The first hours and days of life are of crucial importance for the newborn infant as the infant adapts to the extra-uterine environment. The newborn infant is vulnerable to a range of respiratory diseases. Respiratory distress constitutes a therapeutic challenge for pediatricians and neonatologists [14]. 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 minimum 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 [15] [16]. Noninvasive respiratory support include HHHFNC is considered a cornerstone in management of those infants because it could be adjusted according to physiological state of the affected lungs. The field of Non-invasive respiratory support is growing fast and

several technical advances are added every year [17]. Heated humidified high flow nasal cannula has worldwide spread in neonatal intensive care units as an alternative to nasal continuous positive pressure because it provides positive distending pressure without the obstacles of nCPAP however the evidences to support its use as primary mode of respiratory support of newborn infants are still limited [18]. Accordingly, the present study aimed to study the safety and efficacy of Non-invasive ventilation (HHHFNC) versus Invasive ventilation (CMV) for respiratory support of newborn infants. Our study reveals that HHHFNC is a good alternative mode to mechanical ventilation for management of as primary respiratory support in RDS. However, about 16.7% of newborns who underwent HHHFNC for treatment of RDS did not respond to this mode of noninvasive ventilation and needed intubation and mechanical ventilation. Our study reveals that there was no statistically significant difference between invasive and Non-invasive groups regarding the success of treatment and mortality as a primary outcome. This finding may be explained as our study was limited to 60 cases only. As regard other respiratory support outcomes, the duration of ventilation with Non-invasive ventilation was significantly longer compared to Invasive ventilation (mean 8 versus mean 7 respectively P value = 0.03). also duration of oxygen supply was significantly longer in Non-invasive ventilation longer compared to Invasive ventilation (mean 10 versus mean 8 respectively P value = 0.01). Zohreh and his colleagues conducted a study on 55 newborn with RDS comparing the use of CMV and NIPPV as primary support option and found that Duration of oxygen therapy was 9.28days in CV group and 7.77 days in NIPPV group (P = 0.050). Length of hospital stay in CV group and NIPPV groups were 48.7 and 41.7 days, respectively (P = 0.097) [19]. This is in concordance with the study of Yoder that was conducted on 432 infants with mean gestational age of 32 weeks, randomized to receive either HHHFNC or nCPAP as initial respiratory support. He reported that patients on HHHFNC had significantly longer days on their respiratory support mode in comparison with those nCPAP [20]. As regard secondary outcomes, there were other important findings. Sepsis was higher in Invasive group (50%) than Noninvasive group (23.3%), also pneumothorax was higher in Invasive group (23.3%)) than Noninvasive group (0.0%). While apnea was higher in Noninvasive group (20%) than Invasive group (0.0%) and nasal trauma was higher in Noninvasive group (20%) than Invasive group (0.0%). As regard other secondary outcomes as (Necrotizing enterocolites, Retinopathy of prematurity, Intraventricular hemorrhage and abdominal distension) there were no statistically significant differences were found between the studied groups. In concordance with our study Dustin and his colleagues conducted a study on 4,629 pre-term infants comparing CPAP and Mechanical ventilation and found that no significant difference between two groups in NEC and ROP but IVH was lower in CPAP group [21].

Corresponding Author:
Dr. Hassan Fekry Hassan
Department of pediatrics
Faculty of medicine, Benha University
Fareed Nada Street, Benha, Qalubiya Governorate, Egypt
Telephone: +21003186726
E-mail: drhassan949@gmail.com

References

1. Sweet DG, Carnielli V, Greisen G, Hallman M, Ozek E, Plavka R et al,. (2013): European Consensus Guidelines on the Management of Neonatal Respiratory Distress Syndrome in Preterm Infants - Update. Neonatology. 2013;103(4):353-68.
2. Schmidt B., Asztalos E. V., Roberts R. S., Robertson C. M. T., Sauve R. S., Whitfield M. F: (2003): Impact of bronchopulmonary dysplasia, brain injury, and severe retinopathy on the outcome of extremely low-birth-weight infants at 18 months: results from the trial of indomethacin prophylaxis in preterms. Journal of the American Medical Association.;289(9):1124–1129.
3. Reiterer F, Polin RA (2016): Non-invasive Ventilation in Preterm Infants: A Clinical Review. Int J Pediatr Neonat Care 2: 118. Doi.
4. Donald I, Lord J: (1953): Augmented respiration; studies in atelectasis neonatorum. Lancet.;1:9–17.
5. David J, Gallacher, DJ.; Hart, K. and Kotecha, S (2016): Common respiratory conditions of newborn. Breathe; 12(1):30-42.
6. Gregory GA, Kitterman JA, Phibbs RH, Tooley WH, Hamilton WK: (1971): Treatment of the idiopathic respiratory-distress syndrome with continuous positive airway pressure. N Engl J Med.;284:1333–40.
7. Pape KE, Armstrong DL, Fitzhardinge PM: (1976): Central nervous system pathology associated with mask ventilation in the very low birth weight infant: A new etiology for intracerebellar hemorrhages. Pediatrics;58:473-83.
8. Garland JS, Nelson DB, Rice T, Neu: (1985) Increased risk of gastrointestinal perforations in

neonates mechanically ventilated with either face mask or nasal prongs. Pediatrics;76:406-10.
9. Friedlich P, Lecart C, Posen R, Ramicone E, Chan L, Ramanathan R. A: (1999) randomized trial of nasopharyngeal-synchronized intermittent mandatory ventilation versus nasopharyngeal continuous positive airway pressure in very low birth weight infants after extubation. J Perinatol;19 (6 Pt 1):413-8.
10. Meneses J, Bhandari V, Alves JG: (2012) Nasal intermittent positive pressure ventilation vs nasal continuous positive airway pressure for preterm infants with respiratory distress syndrome. Arch Pediatr Adolesc Med;166:372-6.
11. Owen LS, Morley CJ, Davis PG: (2008) Neonatal nasal intermittent positive pressure ventilation: A survey of practice in England. Arch Dis Child Fetal Neonatal Ed;93: F148-50.
12. Manley BJ, Owen L, Doyle LW, Davis PG: (2012) High-flow nasal cannulae and nasal continuous positive airway pressure use in non-tertiary special care nurseries in Australia and New Zealand. J Paediatr Child Health;48:16-21.
13. Garg S, Sinha S: (2013) Non-invasive ventilation in premature infants: Based on evidence or habit. J Clin Neonatol;2:155-9.
14. David J, Gallacher, DJ.; Hart, K. and Kotecha, S: (2016) Common respiratory conditions of newborn. Breathe; 12(1):30-42.
15. Meharban Singh (1993):3-year experience with neonatal ventilation from a tertiary hospital in Delhi. Indian Pediatr;30:20-5.
16. Steven M. Donn and Sunil K Sinha (2003): Invasive and non-invasive neonatal mechanical ventilation. Respir Care.;48(4):15-20.
17. Hermansen CL and Mahajan A. (2015): newborn respiratory distress. American family physician; 92(11):994-1002.
18. Nath P, Ponnusamy V, Willis K, Bisset L and Clarke P. (2010): Current practices of high and low flow oxygen therapy and humidification in UK neonatal units. Archives of Disease in Childhood.;95(1):893-4.
19. Zohreh, B, Babak, N and Majid M: (2014): Noninvasive Positive Pressure Ventilation or Conventional Mechanical Ventilation for Neonatal Continuous Positive Airway Pressure Failure. Int J Prev Med; 5(8): 1045–1053.
20. Yoder BA, Stoddard RA, Li M, King J, Dirnberger DR, Abbasi S. (2013): Heated humidified high flow nasal cannula versus nasal CPAP for respiratory support in neonates;131(5)1482-e90.
21. Dustin D. Flannery, DO, Elizabeth O'Donnell, Mike Kornhauser, Kevin Dysart, Jay Greenspan, and Zubair H. (2016): Continuous Positive Airway Pressure versus Mechanical Ventilation on the Fist Day of Life in Very Low-Birth-Weight Infants. Am J Perinatol; 33(10): 939–944. doi:10.1055/s-0036-1581130.

11/11/2018