Analytical study for neonates with respiratory distress on Bubble Continuous Positive Airway Pressure admitted to NICU of Minia University Hospital

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Abstract

Introduction: Using nasal continuous positive airway pressure (CPAP) for neonatal respiratory support is highly increasing in low and middle-income countries. It reduces the needs for mechanical ventilation in neonates with respiratory distress (RD) in tertiary hospitals.

Objectives: This is a prospective non-randomized study aims to evaluate the role and efficiency of bubble CPAP in treatment of neonatal respiratory distress and correlation of bubble CPAP failure with different studied demographic, clinical and laboratory variable data.

Patients and methods: The study included all neonates with respiratory distress admitted to neonatal intensive care unit (NICU) - Minia University hospital from 1st of January to 31st of December 2017. The study analyzed the rate of failure and response of management of those patients on bubble CPAP and compared them with other different treatment modalities according to variable recorded demographic, clinical and laboratory data.

Results: Among the 280 cases, 149 patients (53.2%) were treated with oxygen, 52 patients (18.6%) needed to be treated with bubble CPAP, 79 patients (28.2%) needed to be intubated and mechanically ventilated (MV). Our study showed more incidences of bubble CPAP therapy of RD cases with higher gestational ages and birth weight, milder grades of RD, absence of sepsis in comparison with mechanical ventilation and vice versa for comparison with nasal oxygen therapy.

Conclusion: CPAP is an effective treatment of RD leading to significant improvement of outcome reducing hospital stay, need for invasive mechanical ventilation with its harmful adverse effects and thus the case fatality rate of RD cases and so the overall mortality rate of the NICU.

Key words: Respiratory distress, CPAP; Neonates; NICU, Preterm
Background:

Respiratory conditions are the most common reason for admission to a neonatal unit in both term and preterm infants. [1]

Preventive and therapeutic measures for some of the most common causes are well studied and when implemented can reduce the burden of disease. Failure to readily recognize symptoms and treat the underlying cause of respiratory distress in the newborn can lead to short- and long-term complications, including chronic lung disease (CLD), respiratory failure, and even death [2].

Progress in neonatal intensive care is closely related to improvements in the management of respiratory failure in small infants. Current modalities of ventilator assistance range from CPAP to various modes of mechanical ventilation. The advent of less invasive methods of delivering CPAP to infants with RDS is associated with reduced need for intubation and mechanical ventilation and a lower incidence of CLD [3].

Continuous positive airway pressure re-expands collapsed alveoli, splints the airway, reduces work of breathing and improves the respiration [4].

Bubble CPAP, when used appropriately, is more cost effective, less intensive, requires less training and has lower risk of complications [5].

Patients and Methods:

In January 2017, a strategy was established to promote the systematic use of bubble CPAP to avoid intubation and MV in neonates requiring ventilator assistance. All neonates admitted with respiratory distress were treated with oxygen by nasal cannula initially. Observation of clinical response was done. Improved cases did not need more intervention. Resistant and irresponsive cases were conducted on bubble CPAP. Clinical response of bubble CPAP cases was observed, cases either improved and successfully weaned or deteriorated and failed. Excluded cases were intubated and ventilated from the start. Demographic and clinical data of neonates included in the study were collected and analyzed. The data was correlated with CPAP success from one side and compared to other treatment modalities from the other side. Demographic data including weight, age, sex, maternal age, gestational age, cause and grade of respiratory distress, length of hospitalization, duration of ventilator assistance, and mortality were collected.

In addition to laboratory data including hemoglobin, white blood cells count platelet count, C-reactive protein and arterial blood gases which were recorded and analyzed for neonates assisted during the study period. Fisher & Paykel Healthcare bubble CPAP was used in our study[6]. The laboratory investigations were done under supervision of medical staff team of clinical pathology unit in Minia University Hospital as follows:

- CBC (Using SYMEX XP 300 machine).
- ABG (Using BG_800A machine).

Inclusion criteria for neonates treated with bubble CPAP:
1) Respiratory distressed neonates irresponsive to usual oxygen treatment through nasal cannula were included. Oxygen requirement 30% or more to maintain SpO2 92–96% was an indicator for bubble CPAP interference.

**Exclusion criteria:**
1. Severe cardiorespiratory instability in the form of shock and severe hypotension.

**Results:**
Study of clinical characters of bubble CPAP cases demonstrated significant relation of maternal age (p<0.02), length of hospitalization (p<0.001) with bubble CPAP success among the two compared groups. (Table 2).

Significant variation between both succeeded and failed groups was related to birth weight (succeeded vs failed: 2.3±0.8 vs 1.3±0.5kg) and gestational age (succeeded vs failed: 35.7±3 vs 31.3±3.4 weeks) which showed a good chance of success for neonate of NBW and LBW delivered after 30 weeks of gestation (p<0.001) (Table 2) (Figure 3).

Regarding to the pathological causes of RD, 30 cases of RDS had a failure rate of 63.3% vs 36.7% cases succeeded. For 9 cases of neonatal sepsis, a success rate of 88.9% was observed vs 11.1% failed. Four cases suffered from MAS treated with bubble CPAP and all succeeded. For three cases of CHD, two cases succeeded (p<0.01) (Table 2).
Discussion:

This study represents one of few prospective studies on the efficacy of nasal bubble CPAP in treating respiratory distress in both full term and preterm neonates of variable pulmonary and non-pulmonary causes despite definite age for interference. In our study, RD cases showed male predominance for all studied groups (Table 1). This was in agreement with many studies reported predominice of male gender and also reported 1.6 ratios for males to females of total cases [7-10]. It may be related to different hormonal profile which affects surfactant synthesis intrauterine.

Regarding to gestational age, we found that preterm cases were more than full term ones in all studied groups with no significant variation in the mean of GA per weeks. The results were in agreement with two studies observed preterm age group predominance among all treated groups[10,11]. The results are explained by the fact that preterm neonates were more susceptible to RDS because of relative surfactant deficiency.

The outcome of bubble CPAP therapy was expressed by mortality rate of 42.3% in comparison with 22.8% (p<0.01) for oxygen group (Cases died on oxygen only as there was no available CPAP or MV at time of arrest) and also in comparison to 92.4% (p<0.001) for MV group (Table 1)(Figure 1). The results may be reflection of the severity of illness for the selected cases for each group. This was in agreement with one study[7] noted higher mortality rate for mechanically ventilated group versus oxygen/CPAP group, also in agreement with another study [12] who noticed high survival rate for bubble CPAP group. Kawaza et al., 2014[11] divided cases into group treated with bubble CPAP and another group treated with oxygen due to unavailability of the device on time of admission and this explains the higher survival rate of bubble CPAP group in contrary to our result.

We observed significant relation (p<0.001) of higher mean birth weight to CPAP success with highest failure rate for ELBW group (Table 2) (Figure 3). This was in agreement with others [8,13]. Also, we found significant positive correlation (p<0.001) between higher gestational ages (GA) and bubble CPAP success with 100% failure rate for GA≤29 weeks. The same positive correlation was noted by other reports[8, 13-15].

This significant relation may be attributed to correlation of lower birth weight and gestational age with more incidences of apneic episodes, cardiovascular instability and other complications of prematurity.

Regarding cause of RD, RDS represented the majority of failed cases. This was in agreement with Pillai et al., 2011[13] who also correlated severity of RDS with CPAP failure. This reflects the need of more advanced intervention for severe cases of RDS considering surfactant use and/or mechanical ventilation.

In contrary to two studies [14,15], we found significant (p<0.001) longer duration of hospital stay of succeeded cases. The
disagreement in results may be due to high mortality rate of failed cases in our study, most of cases died soon after CPAP failure. As regard to laboratory data, our study correlated sepsis with CPAP failure by using higher CRP levels (p<0.001) and lower platelet counts (p<0.03) at failure of CPAP as indicators (Table 3). This was in agreement with the previous two studies[13,14] who correlated early neonatal sepsis with CPAP failure. The study revealed correlation of CPAP success with improving acidosis and hypoxia as interpreted by our ABG results. This was in concordance with other studies [12,15].

As regard to the outcome of neonates treated with bubble CPAP, the rate of success was 57.7%, 30.8% of cases were ventilated, and 11.5% were deteriorated and died(Figure 2,3).The limited experience of physicians dealing with the Bubble CPAP was one of the causes which led to CPAP failure. Similar results were recorded by other reports [8,12,14] who reported that CPAP relatively succeeded to manage most of included RD cases.

Conclusions:
CPAP is an effective treatment of respiratory distress leading to significant improvement of outcome of admitted neonates. Bubble CPAP use can reduce hospital stay, need for invasive mechanical ventilation with its harmful adverse effects and thus the case fatality rate of RD cases and so the overall mortality rate of the NICU. Bubble CPAP success is significantly correlated with higher birth weight, older gestational age, normal Hb level, proper sepsis control.

Competing interests: The authors declare that they have no competing interests.

Authors’ contributions: SA and AE conceived the study, carried out its designing, coordinated the implementation. EH conducted the statistics of this work. NO conducted and revised the laboratory data of the study. AA participated in the design of the study, analysis and interpretation of data and revised the statistics and final draft of the manuscript. All authors read and approved the final manuscript.

Acknowledgements: Authors wish to thank all staff of the NICU of Minia university hospital for their assistance during the data collection and follow up of patients.

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Date Received 7th December 2018. Accepted 17th January 2019. Published 31th January 2019

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Citation: Abd-Allah ST., El-Mazary AM, Nagwa I Okaily, Ebtesam E Hassan And Amin AM. Analytical study for neonates with respiratory distress on Bubble Continuous Positive Airway Pressure admitted to NICU of Minia University Hospital. Ann Neo J. 2019, 1(1): 3-12.

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