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Descriptive Statistics of the studied cases in An Experience of using High Frequency Oscillatory Mechanical Ventilation in the Treatment of Neonatal Respiratory Distress

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Abstract:

Background:

Respiratory distress is one of the most common problems presented within the first few days of life. Respiratory distress in the newborn may present as apnoea, cyanosis, grunting, inspiratory stridor, nasal flaring, poor feeding, tachypnoea (more than 60 breaths per minute) and intercostal, subcostal or supracostal recessions. It occurs in about 7% neonates. **Aim and Objectives:** The present work aims to study the descriptive data of neonates with respiratory distress treated with with high frequency oscillatory ventilator in neonates. **Patient and Methods :** We prospectively observed 40 neonates who were admitted in Kasr El-Aini NICU and El Monira General hospital with respiratory distress. This population includes all full term and preterm neonates who developed respiratory distress and needed to be mechanically ventilated with high frequency oscillatory ventilator. **Results:** Demographic characteristics of the studied cases studing the gestational age , weight , sex and the mode of delivery of neonates presented with respiratory distress in Kasr El-Aini NICU and El Monira General hospital and needed to be mechanically ventilated with high frequency oscillatory ventilator. **Conclusion:** Only Gestational age, weight and sex had significant diagnostic value in regarding demographic characteristics of the studied cases .

Keywords: High frequency ventilation, demographic data.

Introduction:

Respiratory distress is difficulty in breathing characterized by increase in rate and depth of breathing. It causes decreased feeding, cyanosis, grunting, nasal flaring, intercostal retractions (increased work of breathing), sweating, fever and wheeze. It may be due to inflammation of the parenchyma of the lungs caused by microorganisms, mostly viruses, but may also be due to aspiration of food or gastric acid, especially in recurrent cases, and is a substantial cause of morbidity and mortality in childhood (particularly among children < 5 year of age).

It occurs primarily in premature and low birth weight infants usually male, in those who have not been breastfed, and in those who live in crowded conditions **(Sweet et al., 2017).**

Decreased gestational age predisposes to respiratory distress. There are three times more chances to develop respiratory distress at 37 weeks of gestation than at 39-40 weeks **(Edwards et al., 2013).**

Other risk factors include increasing number of Caesarean section, meconium-stained amniotic fluid, gestational diabetes, maternal chorioamnionitis, or prenatal ultrasonographic findings, such as oligohydramnios or structural lung abnormalities **(Reuter et al., 2014).**

Causes of respiratory distress

A wide variety of pathologic lesions may be responsible for respiratory disturbances **(Parkash et al., 2015)**, including:

- Congenital pneumonia (22.5%),
- Respiratory distress syndrome (RDS) (20.8%),
- Meconium aspiration syndrome (MAS) (16.7%),
- Neonatal sepsis (12.5%),
- Transient tachypnoea of newborn (TTN) (11.7%),
- Birth asphyxia (BA) (7.5%),
- Congenital heart disease (CHD) (4.3%) and others.

While knowing the frequency of various aetiologies, investigations can be minimized by investigating first the most common cause of respiratory distress in our local settings, and hospital policies can be made according to most common aetiologies and their outcomes. To evaluate the causes of respiratory distress it is important to take detailed history, including prenatal, natal and postnatal history along with a thorough physical examination and Laboratory and radiological investigations **(Parkash et al., 2015).**

A chest radiograph should be initially ordered in newborns presenting with respiratory distress. Other helpful laboratory studies include Serum glucose assessment, arterial blood gas (ABG) concentrations, complete blood count (CBC) with differential count, and blood culture. Common respiratory diseases of the newborn such as MAS, congenital pneumonia, RDS, and congenital diaphragmatic hernia (CDH) may lead to respiratory failure and/or persistent pulmonary hypertension in newborns.

Respiratory failure is a leading cause of neonatal mortality and is responsible for nearly 200 newborn deaths each year (1 in 1,100 live births), including preterm newborns, representing 15% of total national neonatal mortality **(Kattan et al., 2013).**

High-frequency oscillatory ventilation (HFOV) is a lung-protective strategy that can be utilized in the full spectrum of patient populations ranging from neonatal to adults with acute lung injury. HFOV is often utilized as a rescue strategy when conventional mechanical ventilation (CV) has failed. HFOV uses low tidal volumes and constant mean airway pressures in conjunction with high respiratory rates to provide beneficial effects on oxygenation and ventilation, while eliminating the traumatic "inflate–deflate" cycle imposed by CV. High-frequency oscillation is a safe and effective rescue mode of ventilation for the treatment of acute respiratory distress syndrome (ARDS) **(Meyers et al., 2019).**

Results

I- Descriptive statistics of the studied cases

Table (1). Demographic Characteristics of the Studied Cases.

		Mean ± SD	**Range**
GA (weeks)		34.6 ± 4.5	28.0 – 41.0
Weight (kg)		2.2 ± 0.9	1.0 – 3.5
		N	**%**
Sex	Male	19	47.5
	Female	21	52.5
Survanta		14	35.0
Mode of delivery	CS	33	82.5
	NVD	7	17.5

Total numbers of cases are 40.

GA = gestational age; CS = cesarean section; NVD = normal vaginal delivery; SD = standard deviation.

Table (1) shows demographic characteristics (data) of the studied cases.

In our study we have a group of 40 cases where the mean of the gestational age (GA) is 34.6 ± 4.5 weeks with a range from 28 to 41.

The mean of their weight is 2.2 ± 0.9 kg with a range from 1 to 3.5. Also we have 19 males with 47.5% and 21 females that represented 52.5% of the whole cases of our study.

Fourteen cases had taken survanta that represented 35% of the studied cases. In our study, 33 cases were delivered by cesarean section that represented 82.5% and 7 were delivered normally that represented 17.5% of cases.

Table (2). Clinical Findings at Birth of the Studied Cases.

		Mean ± SD	**Range**
Apgar score at 1min		3.1 ± 0.8	1.0 – 4.0
Apgar score at 5 min		7.0 ± 1.1	5.0 – 9.0
Downes score		5.9 ± 0.7	5.0 – 7.0
		N	**%**
Causes of using HF ventilation mode	Pneumothorax	11	27.5
	RDS	13	32.5
	PPHT	16	40.0

Total number of cases =40.

HF = high frequency; RDS = respiratory distress syndrome; PPHT = persistent pulmonary hypertension.

Table (2) shows clinical findings at birth of the studied cases.

This table represents the mean of their Apgar score which was 3.1 ± 0.8 at 1min and 7.0 ± 1.1at 5 min, the mean of the Downes score in our cases was 5.9 ± 0.7 with range between 5 to 7. Also we found that the number of neonates who had pneumothorax was 11 with 27.5% of the total number of cases; the number of neonates who had respiratory distress syndrome was 13 with 32.5% and the number of neonates who had PPHT was 16 that represented 40% of the total number of cases.

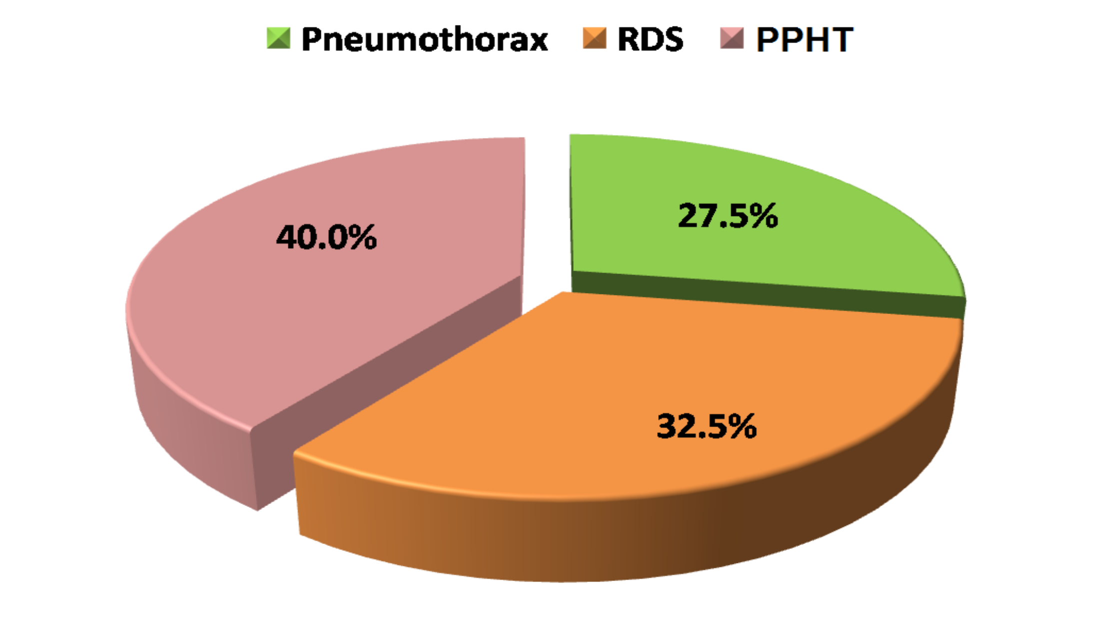

Figure (1). The causes of using high frequency ventilation among the studied cases.

RDS = respiratory distress syndrome; PPHT = persistent pulmonary hypertension.

Figure (1) represents the causes of using high frequency ventilation among the studied cases and the percentage of each.

Table (3). Basic Investigations of the Studied Cases.

		N	%
Positive culture	Blood	7	17.5
	Sputum	2	5.0
Echo	PDA	27	67.5
	PPHT	21	52.5
	PFO	9	22.5
	Free (normal)	2	5.0
Cranial US	Positive findings	17	47.5
Chest x-ray	Pneumothorax	16	40.0
	RDS	16	40.0
	PPHT	8	20.0
	Free	4	10.0

Total number of cases = 40.

PDA = patent ductus arteriosus; PPHT = persistent pulmonary hypertension; PFO = patent foramen ovale; RDS = respiratory distress syndrome; US = ultra sound.

Table (3) shows the basic investigations of the studied cases.

Investigations of the studied cases were done, that were blood cultures, echo, cranial ultrasound and chest x-rays. We found that the total number of blood cultures done were 7 and 2 sputum cultures. Echo was done that denoted 27 cases were with PDA that represented 67.5%, 21 cases had pulmonary hypertension that represented 52.5% and 9 cases had PFO with 22.5% of the whole cases. Cranial ultrasound was done only for 17 cases of the whole candidates that represented 47.5%. Chest x-rays were done that denoted pneumothorax in about 16 cases of the total number of cases which represented 40% of all cases. Also RDS findings were found in about 16 cases with 40% of the total number of studied cases. Chest x-rays were free in only 4 cases that represented 10% of the total number of studied cases.

Table (4). The Initial Modes of Ventilation among the Studied Cases.

		N	**%**
Initial	**HF**	7	17.5
	MV	21	52.5
	CPAP	17	42.5
		Mean ± SD	**Range**
Duration of MV (days)		3.2 ± 1.8	0.5 – 6.0
Duration of CPAP (days)		1.4 ± 1.0	0.5 – 4.0
Total duration before HF (days)		2.3 ± 1.8	0.0 – 6.0

Total number of cases = 40.
HF = high frequency; MV = mechanical ventilation; CPAP = continuous positive airway pressure; SD = standard deviation.

Table (4) and figure (2) show the initial modes of ventilation among the studied cases. We found that the initial mode of ventilation in the studied group was 7 neonates started with high frequency and represented about 17.5% of the total number of cases, also 21 neonates started initially on mechanical ventilation that represented 52.5% of the studied cases. Seventeen neonates were started initially on CPAP that represented 42.5% of the total number of cases. The mean duration that neonates stayed on CPAP was 1.4 days ± 1 with range of 0.5 – 4 days before high frequency. Also we found that the mean of the duration was taken on mechanical ventilation since admission was 3.2 ± 1.8 days before shifting to high frequency mode with range 0.5 - 6.0 days. So the mean of duration the neonates were put either on CPAP or on mechanical ventilation before shifting to high frequency mode was 2.3 ± 1.8 days.

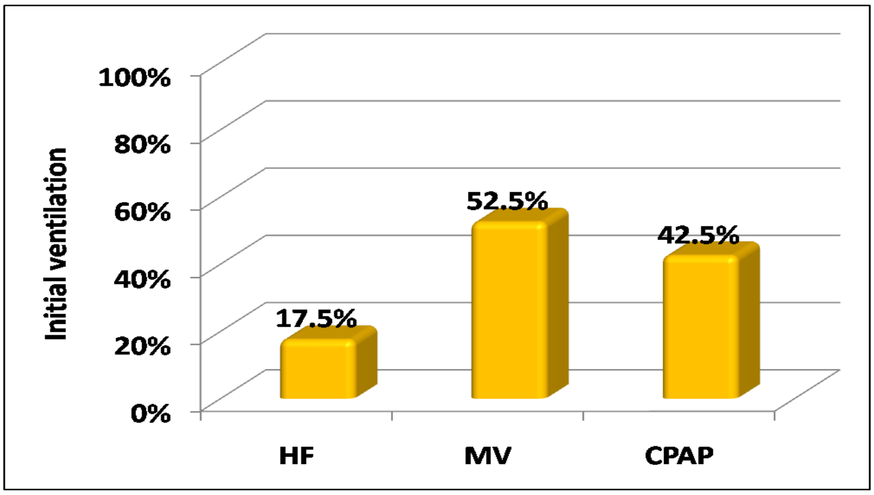

Figure (2). The percentage of the initial mode of ventilation among the studied cases.

This figure represents the percentage of neonates started on each mode of ventilation. Patients representing 17% were put from the start on high frequency ventilation, 52 % started on mechanical ventilation and we found that only 42% of them started with CPAP.

Table (5). Ventilation (Capillary Blood Gases) Parameters of the Studied Cases.

		Mean ± SD	Range
FiO_2 %	**Initial**	85.4 ± 13.5	60.0 – 100.0
	Final	85.2 ± 21.2	36.0 – 100.0
	^P	0.956	
MAP (cmH_2O)	**Initial**	19.9 ± 5.7	10.0 – 30.0
	Final	20.6 ± 7.0	11.0 – 34.0
	^P	0.433	
pH	**Initial**	6.89 ± 1.61	0.00 – 7.64
	Final	7.34 ± 0.13	6.98 – 7.52
	^P	0.064	
PO_2 (mmHg)	**Initial**	55.8 ± 43.5	12.0 – 173.0
	Final	52.9 ± 34.7	28.0 – 194.0
	^P	0.739	
PCO_2 (mmHg)	**Initial**	49.6 ± 23.9	9.0 – 113.0
	Final	35.2 ± 9.8	17.0 – 64.0
	^P	**0.002***	
HCO_3	**Initial**	17.5 ± 5.2	8.0 – 26.0
	Final	20.0 ± 4.6	11.0 – 28.0
	^P	**0.017***	

Total number of cases=40.

*^Paired t-test; *P-value is considered significant if it is less than 0.05; FiO_2 = fraction of inspired oxygen; MAP = mean airway pressure; pH = the negative logarithm of hydrogen ion concentration; HCO_3 = bicarbonate; PCO_2 = partial pressure of carbon dioxide; PO_2 = partial pressure of oxygen; SD = standard deviation.*

Table (5) show the ventilation (capillary blood gases) parameters of the studied cases.

We found by analyzing capillary blood gases (CBGS) that final **PCO_2** is significantly decreased while **HCO_3** is significantly increased in comparing the initial HCO_3 with the final HCO_3 respectively.

DISCUSSION

Our study was conducted on a total number of 40 neonates who developed respiratory distress in the first 24 hours then admitted immediately to kasr El –Aini NICU and received high frequency ventilation either from the start of admission or after failure of assisted ventilation like nasal continuous positive airway pressure (NCPAP) or conventional mechanical ventilation (CMV) as a rescue.

Regarding gestational age (GA) and birth weight (BW) our patients were 34 ± 4.5 weeks of GA with birth weight of 2.2 ± 0.9 kg; while **Bottino et al., (2018)** studied those with 26.6 ± 15.2 weeks of GA with 1.168 ± 0.344 kg birth weight. Also **Lee et al., (2018)** studied

20 very low birth weight (VLBW) infants with a median gestational age of 28.3 weeks with range (23.8 – 33.1) with median birth weight of 1050 g. In addition, **Chen et al., (2019)** studied 2 groups one of which was put on NHFOV and the second group was put on NCPAP with GA less than 37 week and birth weight 1,859.1 ± 567.1 kg and 1,917 ± 477.9 kg respectively.

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