SAS Journal of Medicine
Abbreviated Key Title: SAS J Med
ISSN 2454-5112
Journal homepage: https://saspublishers.com

OPEN ACCESS

Medicine

Risk Factors and Outcome of Pneumothorax in Neonates at Benghazi Children Hospital during Three Years Review

Reema Salih Amrrajaa[1*], Mohammed M Elferjani[1], Nagat B Alghazal[1]

[1]Faculty of Medicine, University of Benghazi, Libya

DOI: 10.36347/sasjm.2022.v08i09.004 | **Received:** 20.08.2022 | **Accepted:** 16.09.2022 | **Published:** 20.09.2022

***Corresponding author:** Reema Salih Amrrajaa
Faculty of Medicine, University of Benghazi, Libya

Abstract **Original Research Article**

Background: Pneumothorax occurs more frequently in the neonatal period than in any other period of life and it is associated with the increased mortality and morbidity. ***Aims:*** This study was conducted to evaluate the frequency of pneumothorax and to assess risk factors, management as well as the outcome of newborn infants with pneumothorax. ***Subjects and Methods:*** A case series study of 112 newborns infants with pneumothorax (PTX) who were admitted and treated at NICU in Benghazi children hospital in Libya for three years period, from January 2018 to December 2020 are included in this descriptive study. Medical records were evaluated for baseline characteristics of neonates, predisposing factors of neonatal PTX, management and mortality. ***Results:*** During the observed three-year period, 5166 neonates were admitted to hospital and 112 of neonates were diagnosed with pneumothorax (CXR confirmed), so the frequency of pneumothorax was 2.2% from neonatal admission. Males outnumbered females by a ratio of 1.9:1. Full term delivery was recorded in 60.7% of patients and 39.3% were pre term. Mean birth weight was 2.5±0.67 kg, with medium weight 2.8kg and minimum weight was 1.08kg and maximum weight was 4.5kg. More than half (68.7%) of patients had birth weight ≥2.5kg. Administration of corticosteroid during pregnancy was recorded in 13.4% of mothers. Concerning mode of delivery, C/S constitute 75%, elective C/S was recorded in 64.3% and 35.7% was emergency, while normal delivery recorded 25%. Spontaneous pneumothorax was found in 32.1%, and secondary pneumothorax was recorded in 67.9% of patients. Age of baby when had PTX was ≤ 48 hours of age in 63.4% of them and >48 hours of age in 36.6%. Side of PTX was at right side in 54.5%, at left side in 22.3% and bilateral in 23.2%. Underlying lung pathology was recorded in 60.7% of patients, 41% had hyaline membrane disease, 8.9% had transient tachypnea of newborn, 6.3% had Congenital Pneumonia, 2.7% had Meconium aspiration syndrome, 0.9% had Multiple cystic lesion in lung and 0.9% had left lung hypoplasia. Majority (83.9%) of patients had no other associated diseases. 9.8% had congenital heart disease, 3.6% had birth asphyxia, 0.9% anemia, 0.9% polycystic kidney and 0.9% had congenital diaphragmatic hernia. 14.3% of patients were treated conservatively, 31.3% were treated with insertion of chest tube, and 54.4% were treated with chest tube and mechanical ventilator. More than half (69.6%) of patients died, (mortality rate was 69.6%). ***Conclusion:*** Apparently that the increase of weigh shows an increase of survival babies. Underlying lung pathology was recorded in 60.7% of patients, Age of baby when had pneumothorax did not affect the outcome. There was no effect of mode of delivery in the rate of death; Majority (83.9%) of patients had no other disease. Administration of corticosteroid during pregnancy did not affect the outcome of babies. The study showed a higher rate of mortality (69.6%).

Keywords: Pneumothorax, neonatal intensive care.

INTRODUCTION

Neonatal period, incorporating the first 28 days of the infant's life, is the most important time for the children's survival worldwide and it accounts for nearly 50% of the deaths of the children below five years of age [1]. Pneumothorax is a collection of air between the lung and the chest wall that develops when air leaks out of the lung. Pneumothorax is one of the most common air leak syndromes that occurs more frequently in the neonatal period than in any other period of life and is a life-threatening condition associated with a high incidence of morbidity and mortality [1]. It has been suggested that early recognition and treatment are beneficial to avoid complications because of hypoxemia, hypercapnia and impaired venous return [2, 3]. A pneumothorax begins with the rupture of an over distended tiny alveoli. Gas

from a ruptured alveolus escapes into the interstitial spaces of the lung, where it may cause interstitial emphysema or dissect along the peribronchial and perivascular connective tissue sheaths to the hilum of lung and subsequently into the pleural space, causing pneumothorax and less commonly pneumomediastinum, pneumopericardium. pneumomediastinum, pneumopericardium and subcutaneous emphysema ,all together known as air leak syndromes [4, 5]. The first inspiratory effort in the infant produces transpulmonary pressure higher than 100 cm of the water column and opens the lungs that were full with fluid in utero. After the first few breaths, this pressure is normalized, and the lungs start to function. If this transpulmonary pressure remains high for a long time, it leads to pneumothorax. This type of pneumothorax is recognized as spontaneous pneumothorax (primary). Secondary pneumothorax occurs in neonates with an underlying pathology like RDS, MAS, pulmonary hypoplasia, as well as in resuscitated neonates [6]. Neonatal PTX is a life threatening condition associated with a high incidence of morbidity and mortality. And is a frequently encountered surgical problem requiring urgent intervention in neonatal intensive care units [7] It occurs more frequently in the first three days of life, and demands prompt management [8, 9]. The rate of occurrence can increase up to 30% in- patient who have an underlying lung disease (e.g. meconium aspiration syndrome (MAS) or who need mechanical ventilation at birth (8). Other factors such as continuous positive airway pressure and positive pressure ventilation further increase the incidence of pneumothorax (8, 10]. Several risk factors for PTX have been described and include prematurity, low birth weight neonates, male sex, neonate born by cesarean section, the presence of respiratory distress syndrome (RDS) or post surfactant treatment, meconium aspiration syndrome (MAS) requiring resuscitation after birth, pneumonia, severe perinatal asphyxia (PNA) requiring vigorous resuscitation at birth, invasive and non-invasive respiratory support like nasal continuous positive pressure ventilation (nCPAP), mechanical ventilation (MV), pulmonary hypoplasia , neonates with urinary tract anomalies, or oligohydramnions and chorioamnionitis [11,12]. For moderate-late preterm infants, risk factors also include high birth weight, male gender, & rupture of membranes longer than 24 hours [12]. PTX must be considered in mechanically ventilated infants who develop unexplained alterations in hemodynamics and pulmonary compliance [13]. Symptomatic PTX occurs in about 0.05% to 0.1% of all live births and in very low birth weight infants, this rate can achieve 3.8% to 9% [2, 14]. Because many newborns have no symptom, PTX should be suspected when newborns who have underlying lung disorders or newborns who are receiving CPAP or are on a ventilator develop worsening trouble breathing (respiratory distress), a drop in blood pressure, or both. Symptomatic PTX is characterized by respiratory distress, which varies from only high respiratory rate to sever dyspnea, tachypnea, and cyanosis. Irritability and restlessness or apnea may be the earliest signs. The onset is usually sudden but may be gradual; an infant may rapidly become critically ill. The chest may appear asymmetric with an increased anteroposterior diameter and bulging of the intercostal spaces on the affected side; other signs may be hyper resonance and diminished or Absence of breath sound. The heart is displaced toward unaffected side, resulting in displacement of cardiac apex. The diaphragm is displaced down ward. Because PTX may be bilateral in 10% of patients, symmetry of finding does not rule it out. In tension PTX, signs of shock may be noted [15]. Hypoxemia and hypercapnia are usually observed in arterial blood gases. Diagnosis of Pneumothorax can be achieved by chest X-ray (CXR), ultrasound or computed tomography (CT) [20]. Despite CT being considered the gold standard for the diagnosis of Pneumothorax in adults, neonatologists always try to avoid CT because it requires infant transportation and exposure to excessive radiation. On the other hand, it has been shown that supine chest x-ray fails to identify a significant number of Pneumothorax especially small and medium PTX [16]. Lung ultrasonography has been successfully used in the diagnosis of Pneumothorax, as a radiation- free, inexpensive, point-of-care tool that the clinician can use at the bedside [17].Therapeutic approach should be adapted to each neonate according to clinical condition of patient and chest radiography; General attitude is that infants with asymptomatic pneumothorax, with no previous lung pathology, treated conservatively with close observation [18, 19]. Breathing 100% oxygen accelerates the resorption of free pleural air. while those patients with symptomatic pneumothorax, thoracic drainage is recommended: thoracentesis in mild cases to evacuate the air from the pleura with a needle, or thoracostomy in severe cases to evacuate the air by placing the thoracic drain with under water seal in the pleural space [19, 25]. A though neonatal pneumothorax is one of the few treatable causes of respiratory difficulty in the early days of life, the mortality rate remains unjustifiably high, at approximately 20%. Additionally, pneumothorax during respiratory distress is associated with an increased risk of intraventricular hemorrhage, chronic lung disease and death [21]. Libya does not have a nationalized registry for pneumothorax to strategize better health promotion towards the predominant risk factors and causative agents. Currently, there are limited studies on the epidemiology of PTX from developing countries including the Middle East [22, 23]. Thus, this study was conducted to identify the frequency, risk factors and outcome among hospitalized neonates with pneumothorax.

STUDY POPULATION

This study was a case series observational study in which all cases of neonatal pneumothorax hospitalized in neonatal intensive care unit in Benghazi

children hospital from the 1st of January 2018 to the end of December 2020 were included in this study. The diagnosis of pneumothorax was suspected based on clinical symptoms, physical examination and confirmed by chest X-ray. The data was collected from the medical records. This study included the preterm and full term neonates.

DATA ANALYSIS

The collected data was entered to Statistical Package of Social Sciences (SPSS) version 23 for windows to be analyzed and summarized in form of descriptive and inferential results. Continuous variables were presented as mean, median, standard deviation minimum and maximum values were calculated. Inferential statistics where used when needed, as x2– test, P-value were considered significant when $p \leq 0.05$. Data were presented in form of tables and figures were the figures done by Microsoft excel 2010.

RESULT

The total number of admissions in 3 years was 5166 and 112 admission diagnosed with PTX, therefore, the frequency of PTX in 3 years is 2.2% from total neonatal admission. 84% (94) of patients were from Benghazi, and 16% (18) from outside Benghazi (figure 1). 77.7% (87) of patients were from private hospitals and 22.3% (25 patients) from public hospitals (Table 1). Full term delivery was recorded in 60.7% (68 patients) of patients and 39.3% (44 patients) were pre term (figure 2). Mean birth weight was 2.5±0.67 kg, with median weight 2.8kg and minimum weight was 1.08kg and maximum weight 4.5kg. More than half (68.7%) of patients had birth weight ≥2.5kg (figure 3). Males outnumbered females by a ratio of 1.9:1 (figure 4).

85.7% (96) of mothers had no any chronic illnesses, 3.5% (4) had bronchial asthma, 2.7% (3) hypothyroidism, 0.9% (1) hepatitis B, 2.7% (3) hypertension and 4.5% (5) had diabetes mellitus (figure 5). Administration of corticosteroid during pregnancy was recorded in 13.4% of mothers (15) (figure 6). Concerning mode of delivery C/S constitute to 75% (84) (figure 7A), elective was recorded in 64.3% (54) from total number of C/S and 35.7% (30) was emergency, while normal delivery was recorded to 25% (28) (figure 7). 13.4% of patients (15) had history of PROM, the time of membrane rupture was at 24 hours of age or less in 7.1% (8) of them , and 6.3% (7) was ruptured at age more than 24 hours (figure 8). 6.2% (7) of patients needed resuscitation at time of delivery, 4 needed PPV, one needed PPV and cardiac compression and 2 needed PPV and intubation (figure 9). Regarding to the use of surfactant therapy, 13.4% (15 patients) received surfactant therapy (figure10). . In this study 73.2% (82 patients) of patients used mechanical ventilator (figure 11), 52.4% (43) of them used it before occurrence of PTX (figure12) .Age of baby ≤ 48 hours when had PTX which was recorded in 63.4% (71 patients) of them and >48 hours of age in 36.6% (41) (figure13). Side of PTX was at right side in 54.5% (61), at left side in 22.3% (25) and bilateral in 23.2% (26) (figure14). Spontaneous pneumothorax was recorded in 32.1% (36), and secondary pneumothorax was recorded in 67.9% (76) of patients (figure 15). Underlying lung pathology was recorded in 60.7% of patients, 41% (46) had hyaline membrane disease, 8.9% (10) had transit tachypnea of newborn, 6.3% (7) had Congenital Pneumonia, 2.7% had Meconium aspiration syndrome, 0.9% had Multiple cystic lesion in lung and 0.9% had left lung hypoplasia (table2). Most common underlying lung pathology in preterm neonates was HMD 75% (33 patients) and spontaneous PTX was the most common cause in full term neonates 54.4% (37 patients) (table3). Regarding type of treatment 14.3% (16 patients) treated conservatively, 31.3% (35 patients) connected to chest tube and 54.4% (61 patients) connected to chest tube and mechanical ventilator (figure16). Majority (83.9%) of patients had no other accompanying diseases while 16.1% (18 patients) had accompanying diseases, include 9.8% (11patients) had congenital heart disease, 3.6% (4 patients) birth asphyxia, 0.9% (one patient) anemia, 0.9% (one patient) polycystic kidney and 0.9% (one patient) had congenital diaphragmatic hernia (table 4). Duration of hospital stay, 77.7% (87) stay in hospital for 1-7 days and 22.3%(25) more than 7 days, with mean duration 5.3±4 days, with median duration 4 days, minimum duration was one day and maximum 24 days (figure17). Complications and associated problems were recorded in 42% (47 patients), hypotension 13.3% (15 patients), sepsis 16.1% (18 patients), thrombocytopenia 3.6% (4 patients), pulmonary hemorrhage 2.7% (3 patients), apnea 1.8% (2 patients), hypocalcaemia 0.9% (one patient), renal impairment 1.8% (2 patients), PDA 0.9% (one patient) and hypernatremia 0.9% (one patient) (table5). More than half (69.6%), 78 patients were died, only 30.4% (34 patients) survived (figure18).All patients, who were treated conservatively, were alive 100% (16 patients) (table11) .No difference in mortality rate between sex, 71.2% of males died and 66.7% of females died (table6). Apparently, the increase of weigh showed an increase of survival, babies with weight 1-1.4kg death rate was 83.3%, while death rate in babies' weight >4kg was 33.3% (table 7). Mode of delivery had no effect on outcome of neonates with PTX (table8). Also, age of neonates when PTX had occurred and administration of corticosteroid during pregnancy did not affect the outcome (table 9), (table 10), respectively. Regarding duration of hospital stay, the mortality rate was 81.6% during the first week of admission and 28% during the other next weeks, this difference was statistically significant p value = 0.0001 (table12). The Total number of admissions in 3 years was =5166 and 112 admission diagnosed with pneumothorax, so the frequency of pneumothorax in 3 years is 2.2% from total neonatal admission.

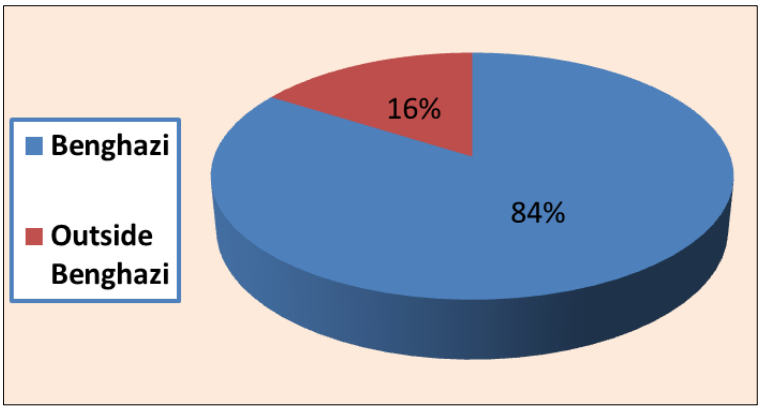

Figure 1: Distribution of patients according to address

Table 1: Distribution of patients according to type of referral hospital

Type of hospital	No.	%
Public hospital	25	22.3
Private	87	77.7
Total	**112**	**100**

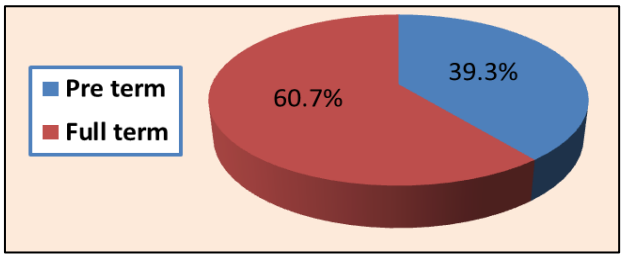

Figure 2: Distribution of patients according to gestational age

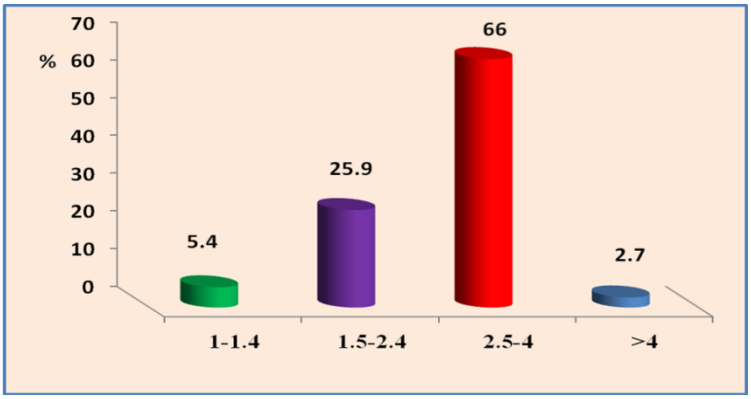

Figure 3: Distribution of patients according to weight

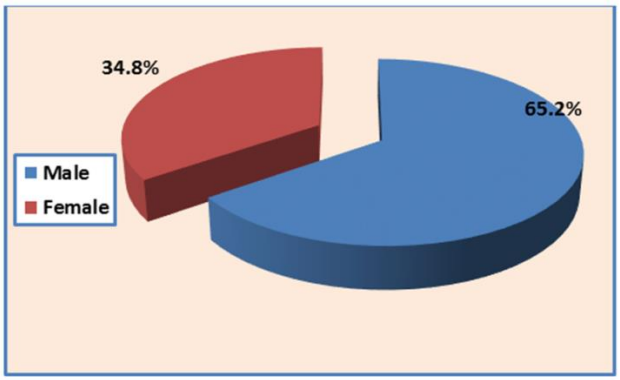

Figure 4: Distribution of patients according to sex

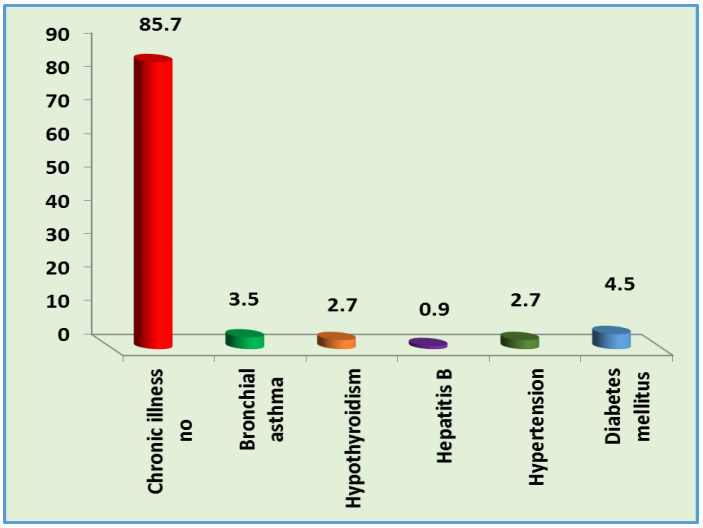

Figure 5: Distribution of mothers according to chronic illness

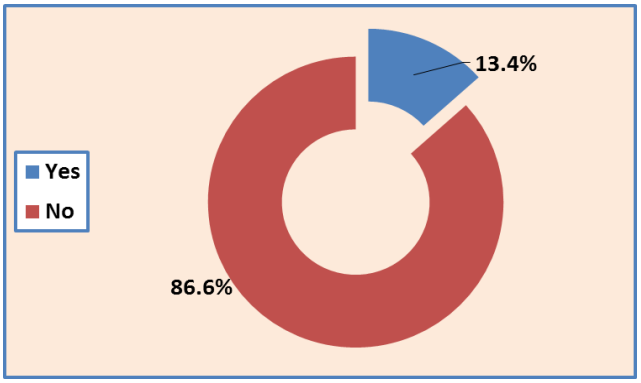

Figure 6: Distribution of patients according to administration of corticosteroid during pregnancy

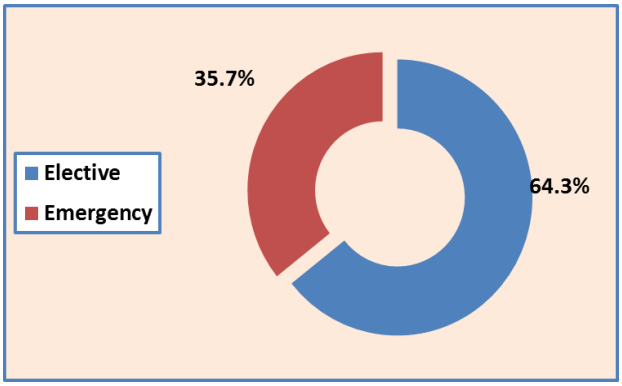

Figure 7: Distribution of patients according to mode of delivery

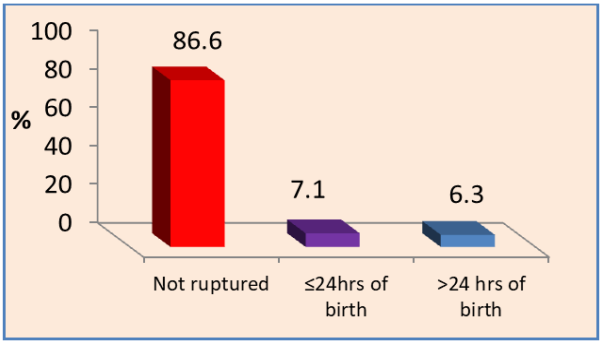

Figure 8: Distribution of patients according to time of membrane rupture

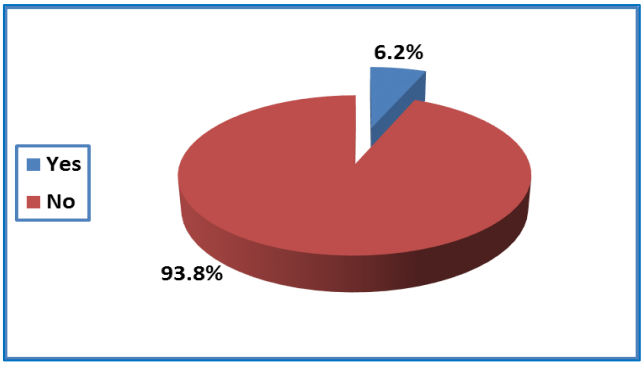

Figure 9: Distribution of patients according if need resuscitation

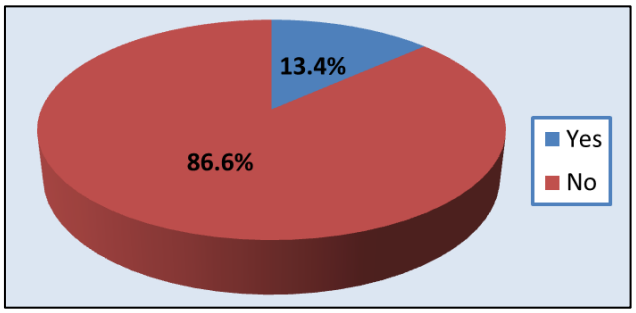

Figure 10: Distribution of patients according use of surfactant

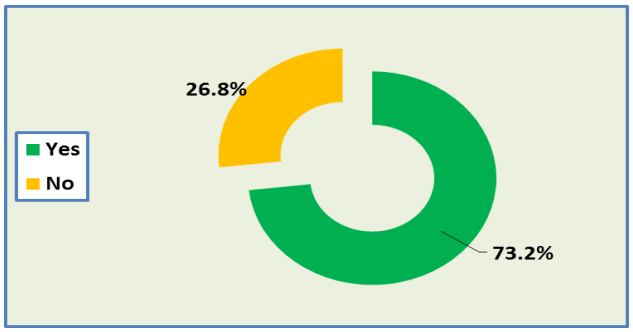

Figure 11: Using mechanical ventilator

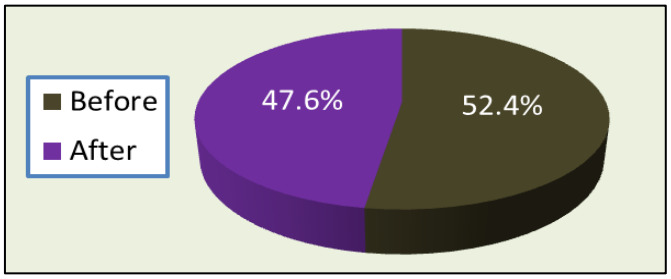

Figure 12: Distribution of patients according to time of using mechanical ventilator before or after occurrence of pneumothorax

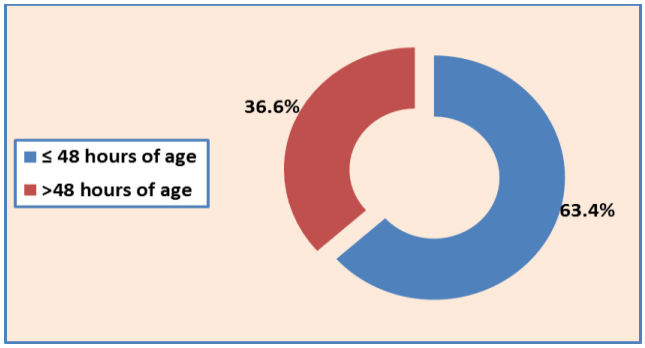

Figure13: Distribution of patients according at what age of baby had pneumothorax

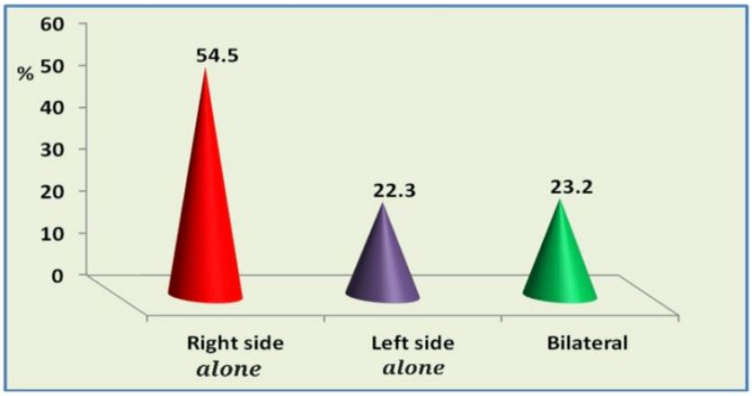

Figure 14: Distribution of patients according to side of pneumothorax

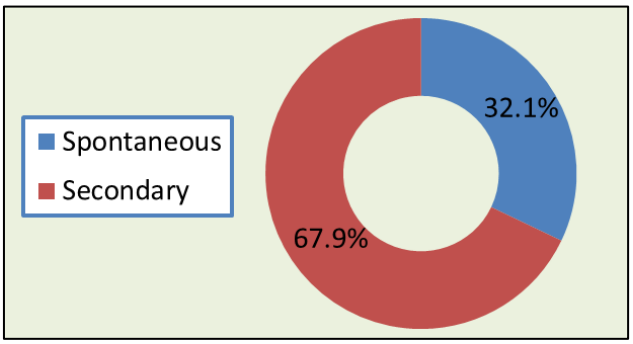

Figure 15: Distribution of patients according type of pneumothorax

Table 2: Distribution of patients according to underlying lung pathology

Underlying lung pathology	No.	%
Hyaline membrane disease	46	41
Spontaneous	44	39.3
Transit tachypnea of newborn	10	8.9
Congenital Pneumonia	7	6.3
Meconieum aspiration syndrome	3	2.7
Multiple cystic lesion	1	0.9
left lung hypopalsia	1	0.9
Total	**112**	**100**

Table 3: Distribution of patients according to underlying lung pathology and maturity

Underlying lung pathology	Maturity				Total	
	preterm		Term			
	No	%	No	%	No	%
Spontaneous	7	15.9	37	54.4	44	39.3
Hyaline membrane disease	33	75	13	19	46	41
Congenital Pneumonia	2	4.5	5	7.4	7	6.3
Meconieum aspiration syndrome	1	2.3	2	3	3	2.7
left lung hypopalsia	0	0	1	1.5	1	0.9
Transit tachypnea of newborn	1	2.3	9	13.2	10	8.9
Multiple cystic lesion	0	0	1	1.5	1	0.9
Total	**44**	**100**	**68**	**100**	**112**	**100**

X^2= 35.327 df= 6 p=0.0001 (Significant).

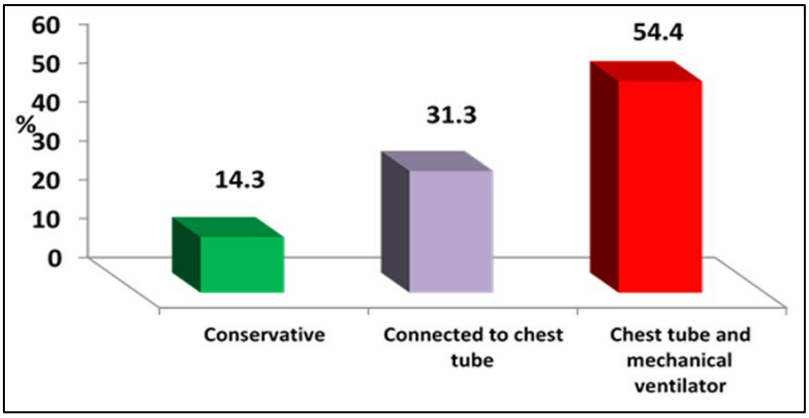

Figure 16: Type of treatments

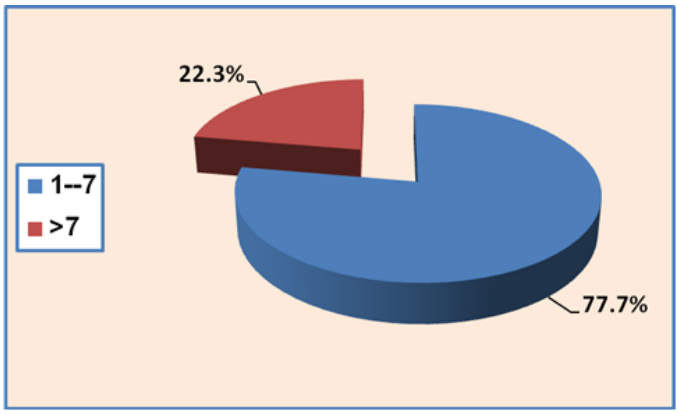

Figure 17: Duration of hospital stay

Mean =5.3day. Std. Deviation =4day. Median=4day.Minimum =1day. Maximum =24days.

Table 4: Distribution of patients according to accompanying diseases

Accompanying diseases	No.	%
No accompanying	94	83.9
Congenital heart disease	11	9.8
Birth asphyxia	4	3.6
Anemia	1	0.9
Polycystic kidney	1	0.9
Congenital diaphragmatic hernia	1	0.9
Total	**112**	**100**

Table 5: Complications and associated problems

Complications and associated problems	No.	%
No complications	65	58
Hypotension	15	13.3
Sepsis	18	16.1
Thrombocytopenia	4	3.6
Pulmonary hemorrhage	3	2.7
Apnea	2	1.8
Hypocalcemia	1	0.9
Renal impairment	2	1.8
PDA	1	0.9
Hyponatremia	1	0.9
Total	**112**	**100**

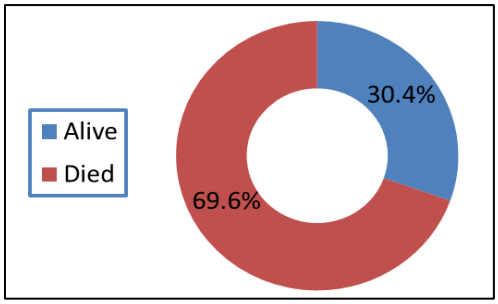

Figure 18: Outcome of the babies

Table 6: Distribution of patients according to outcome of babies and se

Sex	Outcome			
	Died		Alive	
	No.	%	No.	%
Male	52	71.2	21	28.8
Female	26	66.7	13	33.3
Total	**78**	**69.6**	**34**	**30.4**

X^2= 0.251df=1 p=0.617 (Not significant).

Table 7: Distribution of patients according to outcome of babies and weight

Weight /kg	Outcome			
	Died		Alive	
	No.	%	No.	%
1-1.4	5	83.3	1	16.7
1.5-2.4	24	82.8	5	17.2
2.5-4	48	64.9	26	35.1
>4	1	33.3	2	66.7
Total	**78**	**69.6**	**34**	**30.4**

X^2=5.561= 3 p=0.135 (Not significant).

Table 8: Distribution of patients according to outcome of babies and mode of delivery

Mode of delivery	Outcome			
	Died		Alive	
	No	%	No	%
Normal	23	82.1	5	17.9
C/S	55	65.5	29	34.5
Total	**78**	**69.6**	**34**	**30.4**

X^2=2.759df=1 *P*= 0.97

Table 9: Distribution of patients according to outcome of babies and age of baby when had pneumothorax

Age of baby when had pneumothorax	Outcome			
	Died		Alive	
	No	%	No	%
≤ 48 hours of age	46	64.8	25	35.2
>48 hours of age	32	78	9	22
Total	**78**	**69.6**	**34**	**30.4**

X^2=2.162df=1 *P*=0.141

Table 10: Distribution of patients according to outcome of babies and administration of corticosteroid during pregnancy

Administration of corticosteroid during pregnancy	Outcome			
	Died		Alive	
	No	%	No	%
Yes	11	73.3	4	26.7
No	67	69.1	30	30.9
Total	**78**	**69.6**	**34**	**30.4**

X^2=0.112df=1 *p=0.738*

Table 11: Distribution of patients according to outcome of babies and type of treatments

Type of treatments	Outcome			
	Died		Alive	
	No	%	No	%
Conservative	0	0	16	100
Connected to chest tube	24	68.6	11	31.4
Chest tube and mechanical ventilator	54	88.5	7	11.5
Total	**78**	**69.6**	**34**	**30.4**

X^2=47df=2 *P* =0.0001

Table 12: Distribution of patients according to outcome of babies and duration of hospital stay

Duration of hospital stay/days	Outcome			
	Died		Alive	
	No	%	No	%
1-7	71	81.6	16	18.4
>7	7	28	18	72
Total	**78**	**69.6**	**34**	**30.4**

X^2=26.399=1 *P*=0.0001

6. DISCUSSIONS

During the observed three-year period 5166 neonates were admitted to hospital and 112 of neonates were diagnosed with PTX, so the frequency of PTX was 2.2% from total neonatal admission, and this result is similar to other studies in literature, one of these studies showing that the PTX was diagnosed in 124 newborns giving the frequency of 1.9% [26]. Also recorded in another study that during the study period there were 48,968 live births and 71 cases of pneumothorax, giving frequency of pneumothorax of 0.14% [29]. While the frequency was higher in other studies like a study done by my colleague Dr. Laylay FA 2020 which was 11% [24] Majority (84%) of patients were from Benghazi, and 16% were from outside Benghazi. Majority (77.7%) of babies were born in private hospitals, and 22.3% were born in public hospitals, which explains the limited information about delivery note and APGAR score during delivery from most transferred cases GA was defined as the best estimation based on early prenatal ultrasound examination, last menstrual period, obstetric examination, and Ballard examination [45]. In this study full term delivery was recorded in 60.7% of patients and 39.3% were pre term, no one was post term, and this result is similar to the result of a study conducted by Shen A *et al.*, [25] where 74.1% of neonates were term, may be the explanation of that is, the elective C/S was the main way for childbirth in most cases of this study (most of cases were from private hospital), so we expect that the GA of those neonates who borne by elective C/S is term. In most other studies PTX was common in preterm [24, 26, 28, 30-32] , because immaturity of the lung parenchyma and due to the lack of surfactant which increases surface tension and causes "air capture" with the first breath in these alveoli, which results in their rupture and that is why PTX is more common in preterm newborns [20, 33]. Neonatal PTX is more often seen in neonates with low birth weights and that is confirmed by several studies [26, 28, 30-32], but in this study 66% of patient's weights were between 2.5 and 4 Kg (normal birth weight), because as we mentioned before , that most of neonates in this study are term, so we expect that the birth weight is within normal range. It is known that PTX occurs more often in males than females, this was similar in this study, where males outnumbered females by a ratio of 1.9:1 and this was similar as in literature [25, 28, 30]. However, the greater incidence of PTX in males remains unexplained. Majority of mothers (85.7%) free from chronic disease, 14.3% of them had chronic diseases, bronchial asthma in 3.5%, hypothyroidism in 2.7%, hypertension in 2.7% and hepatitis B in 0.9% and 4.5% of mothers had diabetes mellitus, the diabetes mellitus associated with the increased risk of neonatal respiratory morbidity in a study conducted by (Abbas jaafar *et al.*, 2020) [44]. Administration of corticosteroid during pregnancy was recorded in 13.4% of mothers, so antenatal steroid use was not associated with PTX which is in agreement with the result of study conducted by Iris Santos Silva and his colleague 2016[41], which also showing that the antenatal steroid use was not associated with PTX . But this result must be confirmed by conducting other study, because only 13.4% of mothers received corticosteroid during pregnancy (small percentage). Concerning mode of delivery C/S constitute to 75%, elective was recorded in 64.3% from the total number of C/S and 35.7% was emergency, while normal delivery was recorded in 25%, similarly to almost all studies in the literature, the caesarean section was the most common mode of delivery and Caesarean section is another risk factor for PTX, after elective caesarean section, the baby was not stressed and often had ‘wet lungs’ followed by forced respiration that may lead to PTX [33], 13.4% of patients had history of PROM, the time of membrane rupture was at 24 hours of age or less in 7.1% of them, and 6.3% was ruptured at age more than 24 hours, only one study conducted by Almatary *et al.*, showed that the PROM was the most common accompanying disorder recorded in (89.5%) of patients [28], Prolonged rupture of membranes may be linked to

unfavorable condition of neonates at birth and the requirement for active resuscitation and mechanical ventilation. Resuscitation was needed for 6.2% (7 patients), 4 of them needed positive pressure ventilation, one needed PPV and cardiac compression and 2 needed PPV and intubation**.** One minute and five minute Apgar score were predictor for mortality in some studies [28, 30], in this study most of cases where transferred from private hospital and Apgar score was not documented in most of transferred cases. Spontaneous pneumothorax was recorded in 32.1%, and secondary pneumothorax was recorded in 67.9% of patients, in agreement with other studies in the literature [11, 28, 31, 32]. Surfactant was used in13.4% of patients, but the limitation of this study was that the time of surfactant administration before or after PTX not included, so there will be a limited information about the effect of surfactant administration on outcome of neonates with PTX, in study conducted by Dr. Laylay FA [24] 30.9% of patients received surfactant 62% of them before PTX had occurred, and there was no significant difference in mortality rate in neonates receiving surfactant and those did not receive, this finding was different from the finding of Navaei and his colleagues [32], in their study the mortality rate was significantly higher in those neonates who received surfactant therapy than in those who did not receive it. Using mechanical ventilator was needed by 73.2%. Mechanical ventilator was used before occurrence of pneumothorax in 52.4% and after in 47.6%. Mechanical ventilation was documented as a predisposing factor of PTX, this result is consistent with the results in another studies, like the study conducted by Abdullatif *et al.*, [31] which showed that 89.83% of the cases with PTX were on MV, Navaei *et al.*, [32] also found that MV was the common predisposing factor in their study (86% of cases were on MV before occurring of PTX), while in the study conducted by Mannan *et al.*, [27] and another study conducted by Vibedel *et al.*, [29] showed that no patients were on MV on their study (MV wasn't documented as predisposing factor in their study). PTX occurs more frequently during the neonatal period than at any other time of life and is most often observed in the first 3 days of life [34, 35]. In agreement with the literature [25, 29, 30], in the present study age of baby when had PTX was ≤ 48 hours of age in 63.4% of them and >48 hours of age in 36.6%. Side of PTX was at right side in 54.5%, at left side in 22.3% and bilateral in 23.2%. Moreover, that was similar to other studies in literature [11, 27, 30-32]. The flat angle of the right main bronchus and malposition of the endotracheal tube down to the right main bronchus or perforation by suction catheter may be the main causes of right-sided PTX. Early diagnosis and appropriate treatment are crucial in neonatal PTX because it can cause sudden cardio pulmonary deterioration, in this study 14.3% of neonate with PTX treated conservatively, 31.1% connected with chest tube and 54.4% treated with both chest tube and mechanical ventilator and no one treated with needle aspiration. Similarly to another studies in the literature that also reported that the chest tube insertion and connection with mechanical ventilator was the common modality of treatment. [26, 29, 33]. In disagreement with the results of this study, a conservative treatment was the most common modality of treatment (76.6%) in the study conducted by Ashen *et al.*, [25], and 77.11% in the study conducted by Mannan *et al.*, [27] Underlying lung pathology was recorded in 60.7% of patients, HMD was the major underlying lung pathology in this study (41%), and also HMD was the major underlying lung pathology in other studies in literature. [27, 29-32], HMD was defined by the following clinical criteria: respiratory difficulty, persistent oxygen requirement over the first 48 to 96 hours of life, and characteristic chest x-ray findings [45]. In this study the most common underlying lung pathology in term baby was spontaneous (54.4%) and HMD was the most common underlying lung pathology in preterm neonates (75%), as we know that HMD is more common in preterm neonates, but also can be seen in term babies born by C/S, or IDM or neonates with history of birth asphyxia and in this study 13 neonates were term and have HMD. Meconium aspiration syndrome seen in term and post term neonates, in this study there were (3 patients) of MAS, two of them were term neonates and one was late preterm. Majority (83.9%) of patients had no other diseases, 9.8% had congenital heart disease, 3.6% birth asphyxia, 0.9% anemia, 0.9% polycystic kidney and 0.9% had congenital diaphragmatic hernia, while in the study conducted by Esme H, Dogru O, Eren S, *et al.*, [21], showing that the most common accompanying disorders were, hydrocephalus 4%, hyperbilrubinemia 2%, upper gastro intestinal hemorrhage 2%, pectus excavatum 2%, TOF 2% and hydronephrosis in 2%.

No complications were recorded in 58% of patients, hypotension in 13.3%, sepsis in 16.1%, Thrombocytopenia in 3.6%, pulmonary hemorrhage 2.7%, apnea in 1.8%, Hypocalcemia in 0.95%, renal impairment in 1.8%, PDA in 0.9% and Hyponatremia in 0.9%, also in study conducted in Bangladesh by Abdul Mannan *et al.*, 2019 [27], showing that 67.5 % had no complication and 20.5% had sepsis, 8.4% hypotension , 1.2% sepsis with NEC, 1.2% sepsis with DIC and sepsis with DIC and IVH recorded in 1.2%. More than half (69.6%) of patients died giving high fatality rate, only 30.4% survived, while in other studies the mortality was 21% [21], *7.23%* [27], *29.1%* [28], 13 % [29], *10%*,[30], 62.7% [31] and 65% [32], in different countries. The mortality rate often depends on other underlying factors rather than PTX per – se, may be the explanation of high mortality rate in this study is that 52.4% of patients were already in serious condition and were on mechanical ventilator even before PTX had occurred. Risk factors for mortality from neonatal pneumothorax were analyzed in two groups of neonates, depending on the outcome (survivors/died). In this study, there was no significant difference for mortality between sexes. More than half (71.2%) of

male were died and 28.8% were alive, 66.7% of female were died and 33.3% were alive, this difference was not significant p value =0.617, similarly Navaei's study also showed no significant difference for mortality between sexes [32]. Apparently that the increase of weight shows an increase of survival, babies with weight 1-1.4kg death rate was 83.3%, while death rate in babies' weight >4kg was 33.3%, but this difference was not statistically significant p value = 0.135, and also other studies recorded that low birth weight was statistically significant risk factors for mortality [26, 28, 30-32]. There was no effect of mode of delivery in the rate of death, 82.1% of newborns were born with normal delivery died and 65.5% were born from C/S died, and this in agreement with the result of study done by Iris Santos Silva and his colleague 2016[41]. Age of baby when had PTX does not affect the outcome, age ≤ 48 hours 64.8% of them die, and age >48 hours 78% of them die, this difference was not statistically significant p value = 0.141. Administration of corticosteroid during pregnancy does not affect the outcome of babies, 73.3% of receiving corticosteroid during pregnancy were died, and 69.1% of not receiving corticosteroid also died, this result correlates also with the result of Iris Santos Silva and his colleague 2016 [41], but this result must to be confirmed by other study, because only 13.4% (small percentage) of mothers received corticosteroid during pregnancy. Type of treatments shows difference in outcome, no one of conservative treatment was died, because already they have mild symptoms and that is why treated conservatively. 68.6% who connected to chest tube were died and 88.6% who connected to chest tube and mechanical ventilator were died, this difference was statistically significant p value was 0.0001, so the use of MV with chest tube insertion were the most common modality of treatment in died neonates with PTX (88.5%), and that correlates with the findings of other studies in literature [21, 42, 43].

Regarding duration of hospital stay and mortality, It was observed that the mortality rate was high during the first week of admission, as compared to the other next weeks, the mortality rate was 81.6% during the first week of admission and 28% during the other next weeks, the mortality is high in first week may be because that more than half of cases were in serious condition even before occurrence of PTX (52.4% were on MV before occurrence of PTX), so we expect that most of them died in the first week of admission and Also, because this study include all neonates regardless the GA and birth weight (minimum birth weight was 1.08 Kg), so those who are severely premature, expect to die early. An important strength of the present study was that these preliminary data add to the understanding of the epidemiology of PTX in Benghazi. The study results will serve as the basis for future research and contribute to developing and optimizing strategies to fight these problems. This includes educating healthcare providers in the NICU about the factors that affect the morbidity and mortality of neonates with pneumothorax to improve the standards of NICU.

REFERENCES

1. WHO. (2016). Neonatal mortality, Situation and trends. Global Health Observatory (GHO) data, World Health Organization.
2. Smith, J., Schumacher, R. E., Donn, S. M., & Sarkar, S. (2011). Clinical course of symptomatic spontaneous pneumothorax in term and late preterm newborns: report from a large cohort. *American journal of perinatology*, *28*(02), 163-168.
3. Ogata, E. S., Gregory, G. A., Kitterman, J. A., Phibbs, R. H., & Tooley, W. H. (1976). Pneumothorax in the respiratory distress syndrome: incidence and effect on vital signs, blood gases, and pH. *Pediatrics*, *58*(2), 177-183.
4. Crowley, M. A. (2014). Neonatal Respiratory Disorders. In: Martin, R. J., Fanaroff, A. A., & Walsh, M. C. (Eds.). Fanaroff and Martin's Neonatal-Perinatal Medicine: Diseases of the Fetus and Infant. *10th edition, Philadelphia: Elsevier Saunders*, 2, 1113-36.
5. Duong, H. H., Mirea, L., Shah, P. S., Yang, J., Lee, S. K., & Sankaran, K. (2014). Pneumothorax in neonates: trends, predictors and outcomes. *Journal of neonatal-perinatal medicine*, *7*(1), 29-38.
6. Abdellatif, M. A., & Abdellatif, D. A. (2012). Pneumothorax in the neonatal intensive care unit in Cairo University Hospital. *J Egypt Soc Parasitol*, *42*(2), 495-506.
7. Kottmeier, P. K. (1986). Birth trauma. In: Welch, K. J., Randolph, J. G., Ravitch, M. M., O'Neill, J. A., & Rowe, M. I. (eds). Pediatric Surgery. *Chicago: Year Book Medical Publishers*, 230-237.
8. Seguier-Lipszyc, E., Elizur, A., Klin, B., Vaiman, M., & Lotan, G. (2011). Management of primary spontaneous pneumothorax in children. *Clinical Pediatrics*, *50*(9), 797-802.
9. Hill, A., Perlman, J. M., & Volpe, J. J. (1982). Relationship of pneumothorax to occurrence of intraventricular hemorrhage in the premature newborn. *Pediatrics*, *69*(2), 144-149.
10. Litmanovitz, I., & Carlo, W. A. (2008). Expectant management of pneumothorax in ventilated neonates. *Pediatrics*, *122*(5), e975-e979.
11. Bhat, R., & Ramdas, V. (2013). Predisposing factors, incidence and mortality of pneumothorax in neonates. *Minerva Pediatrica*, *65*(4), 383-388.
12. Colin, A. A., McEvoy, C., & Castile, R. G. (2010). Respiratory morbidity and lung function in preterm infants of 32 to 36 weeks' gestational age. *Pediatrics*, *126*(1), 115-128.
13. Venkatesh, M. P. (2012). Pulmonary air leak. *Manual of neonatal care, Seventh edition, Cloherty JP, Eichenwald EC, Stark AR.,(editors). Lippincott Williams & Wilkins, Wolters Kluwer business, Pheladelphia*, *24*, 352-358.

14. Kitsommart, R., Martins, B., Bottino, M. N., & Sant'Anna, G. M. (2012). Expectant management of pneumothorax in preterm infants receiving assisted ventilation: report of 4 cases and review of the literature. *Respiratory care*, *57*(5), 789-793.
15. Kliegman, R. M., Stanton, B. F., ST Geme, J. W., Schor, N. F., & Behman, R. E. (2016). Nelson text book of pediatric 20th edn, Extrapulmonary Extravasation of air (*Pneumothorax, pneumomediastinum, Pulmonary Interstitial Emphysema*), pp 750-752.
16. Ball, C. G., Kirkpatrick, A. W., Laupland, K. B., Fox, D. L., Litvinchuk, S., Dyer, D. M., ... & Mulloy, R. (2005). Factors related to the failure of radiographic recognition of occult posttraumatic pneumothoraces. *The American journal of surgery*, *189*(5), 541-546.
17. Ianniello, S., Di Giacomo, V., Sessa, B., & Miele, V. (2014). First-line sonographic diagnosis of pneumothorax in major trauma: accuracy of e-FAST and comparison with multidetector computed tomography. *La radiologia medica*, *119*(9), 674-680.
18. Henry, M., Arnold, T., & Harvey, J. (2003). BTS guidelines for the management of spontaneous pneumothorax. *Thorax*, *58*(Suppl 2), ii39.
19. MacDuff, A., Arnold, A., & Harvey, J. (2010). Management of spontaneous pneumothorax: British Thoracic Society pleural disease guideline 2010. *Thorax*, *65*(Suppl 2), ii18-ii31.
20. Light, R. W., O'Hara, V. S., Moritz, T. E., McElhinney, A. J., Butz, R., Haakenson, C. M., ... & Campbell, S. C. (1990). Intrapleural tetracycline for the prevention of recurrent spontaneous pneumothorax: results of a Department of Veterans Affairs cooperative study. *Jama*, *264*(17), 2224-2230.
21. Esme, H., Dogru, O., Eren, S., Korkmaz, M., & Solak, O. (2008). The factors affecting persistent pneumothorax and mortality in neonatal pneumothorax. *The Turkish Journal of Pediatrics*, *50*(3), 242.
22. Ngerncham, S., Kittiratsatcha, P., & Pacharn, P. (2005). Risk factors of pneumothorax during the first 24 hours of life. *J med Assoc thai*, *88*(8), S135-41.
23. Boo, N. Y., Cheah, I. G. S., & Malaysian National Neonatal Registry. (2011). Risk factors associated with pneumothorax in Malaysian neonatal intensive care units. *Journal of paediatrics and child health*, *47*(4), 183-190.
24. Laylay, F. A. (2017). Pneumothorax in neonates: incidence, risk factors and outcome at Benghazi medical Centre. (*Approved for master degree from Benghazi medical University* 2020).
25. Shen, A., Yang, J., Chapman, G., & Sunday, P. (2020). Can neonatal pneumothorax be successfully managed in regional Australia?. *Rural and Remote Health*, *20*(3), 5615. https://doi.org/10.22605/RRH5615
26. Okumuş, M., & Umut Zübarioğlu, A. (2020). Neonatal Pneumothorax-10 years of experience from a single center. *J. Pediatr Res*, 7(2), 163-167. Doi: 10.4274/jpr.galenos.2019.50133
27. Mannan, M. A., Dey, S. K., Jahan, N., Iqbal, S., Karim, S. R., & Ferdous, N. (2019). Spectrum of Neonatal Pneumothorax at a Tertiary Care Hospital of Bangladesh: A Retrospective Observational Study. *Bangladesh Critical Care Journal*, *7*(1), 12-19.
28. Al Matary, A., Munshi, H. H., Abozaid, S., Qaraqei, M., Wani, T. A., & Abu-Shaheen, A. K. (2017). Characteristics of neonatal pneumothorax in Saudi Arabia: three years' experience. *Oman Medical Journal*, *32*(2), 135.
29. Vibede, L., Vibede, E., Bendtsen, M., Pedersen, L., & Ebbesen, F. (2017). Neonatal pneumothorax: a descriptive regional Danish study. *Neonatology*, *111*(4), 303-308.
30. Shakir Al-Fahham, F., Khaleel, K., & Mohammedridha, A. Q. (2015). A Prospective Study of Neonatal Pneumothorax in Holy Karbala. *Kerbala Journal of Medicine*, *8*(1), 2093-2097.
31. Abdellatif, M. A., & Abdellatif, D. A. (2012). Pneumothorax in the neonatal intensive care unit in Cairo University Hospital. *J Egypt Soc Parasitol*, *42*(2), 495-506.
32. Navaei, F., Aliabadi, B., Moghtaderi, M., & Kelishadi, R. (2010). Predisposing factors, incidence and mortality of pneumothorax in a neonatal intensive care unit in Isfahan, Iran. *Zhongguo dang dai er ke za zhi= Chinese journal of contemporary pediatrics*, *12*(6), 417-420.
33. Melton III, L. J., Hepper, N. G., & Offord, K. P. (1979). Incidence of spontaneous pneumothorax in Olmsted County, Minnesota: 1950 to 1974. *American Review of Respiratory Disease*, *120*(6), 1379-1382.
34. Ovalı, F. (2000). Hava kaçagi sendromlari. *Neonatoloji (Dag aog lu T, ed), Istanbul: Nobel Tıp Kitabevi*, 299-303.
35. Zenciroğlu, A., Aydemir, C., Baş, A. Y., & Demirel, N. (2006). Evaluation of predisposing and prognostic factors in neonatal pneumothorax cases. *Tuberkuloz ve Toraks*, *54*(2), 152-156.
36. Cizmeci, M. N., Kanburoglu, M. K., Akelma, A. Z., Andan, H., Akin, K., & Tatli, M. M. (2015). An abrupt increment in the respiratory rate is a sign of neonatal pneumothorax. *The Journal of Maternal-Fetal & Neonatal Medicine*, *28*(5), 583-587.
37. Cattarossi, L., Copetti, R., Brusa, G., & Pintaldi, S. (2016). Lung ultrasound diagnostic accuracy in neonatal pneumothorax. *Canadian Respiratory Journal*, *2016*. 6515069.
38. Arda, I. S., Gürakan, B., Al· Iefendioğlu, D., & Tüzün, M. (2002). Treatment of pneumothorax in newborns: use of venous catheter versus chest tube. *Pediatrics international*, *44*(1), 78-82.

39. Bruschettini, M., Romantsik, O., Zappettini, S., O'Donnell, C. P., & Calevo, M. G. (2019). Needle aspiration versus intercostal tube drainage for pneumothorax in the newborn. *Cochrane Database of Systematic Reviews*, (2). CD011724.
40. Venuta, F., Diso, D., Anile, M., Rendina, E. A., & Onorati, I. (2017). Chest tubes: generalities. *Thoracic Surgery Clinics*, *27*(1), 1-5.
41. Silva, I. S., Flôr-de-Lima, F., Rocha, G., Alves, I., & Guimarães, H. (2016). Pneumothorax in neonates: a level III Neonatal Intensive Care Unit experience. *Journal of Pediatric and Neonatal Individualized Medicine (JPNIM)*, *5*(2), e050220-e050220.
42. Watkinson, M., & Tiron, I. (2001). Events before the diagnosis of a pneumothorax in ventilated neonates. *Archives of Disease in Childhood-Fetal and Neonatal Edition*, *85*(3), F201-F203.
43. Atıcı, A., Satar, M., & Narlı, N. (1996). Mechanic ventilation in newborn. *Çukurova Univ Tıp Fak Dergisi*, *2*, 128-132.
44. Al-Anbari, A. J. K., & Abid, J. K. (2020). Evaluation of Pneumothorax in Neonates in Al Immamian Alkadhomain Medical City. *European Journal of Molecular & Clinical Medicine*, *7*(2), 214-219. DOI: https://doi.org/10.31838/ejmcm.07.02.34
45. Canadian Neonatal Network. Abstractor's Manual v2. 0. 0 [Internet]. Toronto, Canada: Canadian Neonatal Network; 2009 [updated 2012 Jan; cited 2012 Nov 16]. Available from: http://www.canadianneonatalnetwork.org/portal/CNNHome/Publications.aspx.