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Original article

Neonatal Pneumothorax: Incidence, Predisposing Factors, and Outcomes in a Libyan Neonatal Unit at Al Wahda Teaching Hospital, Derna

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Abstract

Neonatal pneumothorax (NP) presents a significant challenge in neonatal care, often leading to respiratory distress and morbidity. Despite advancements, NP remains a leading cause of concern. This study aims to investigate the incidence, predisposing factors, survival, and outcomes associated with NP. A retrospective descriptive analysis was conducted on the medical records of neonates admitted to a city hospital in Derna, Libya, from January 2016 to December 2021. Patients diagnosed with NP were identified, and their records were reviewed. Baseline characteristics, predisposing factors, and outcomes were analyzed. The incidence of NP was 1.37% among total live births and 8.3% among hospitalized neonates. Predisposing factors included respiratory distress syndrome (RDS) and thoracic air leak. Survival rate was 79.2%, with mortality primarily associated with comorbidities such as cyanotic congenital heart disease (CHD) and intraventricular hemorrhage (IVH). Treatment involved chest tube placement, with a resolution time averaging 16 hours. Most cases occurred within 24 hours post-birth, primarily unilateral. The average hospital stay was 3 days. NP predominantly occurred within 24 hours post-birth, with a high survival rate. Predisposing factors included RDS and thoracic air leak. Survival was influenced by comorbidities such as CHD and IVH. These findings emphasize the importance of timely identification and management of NP and its associated risk factors to improve outcomes.

Keywords: *Neonate, Pneumothorax, Incidence, Risk factors, Outcomes.*

Introduction

Neonatal pneumothorax (NP), characterized by the presence of air in the pleural space of newborn infants, represents a significant challenge in the realm of neonatal care [1]. Despite advances in medical technology and interventions, NP remains a leading cause of respiratory distress and morbidity in neonates, posing serious threats to their health and well-being [2,3].

The incidence of NP varies across different neonatal populations, with reported rates ranging from 1.9 to 6.0 per 1,000 live births globally [4]. While the etiology of NP can be multifactorial, it is commonly associated with iatrogenic causes such as mechanical ventilation, trauma during delivery, and invasive procedures. Additionally, underlying pulmonary conditions such as respiratory distress syndrome (RDS), meconium aspiration syndrome (MAS), and congenital pulmonary malformations further predispose neonates to the development of pneumothorax [5-8].

The clinical presentation of NP can range from subtle signs of respiratory distress to severe cardiorespiratory compromise, necessitating prompt recognition and intervention. Diagnostic modalities such as chest X-ray and ultrasound play a crucial role in confirming the diagnosis and assessing the extent of lung collapse [9,10]. Management strategies for NP encompass a spectrum of interventions, including observation, needle aspiration, chest tube insertion, and surgical repair, tailored to the severity of the pneumothorax and the clinical status of the neonate [11].

Despite advances in our understanding of NP, several challenges persist in its management and prevention. These include variability in clinical practice, lack of standardized guidelines, and the potential for complications associated with invasive procedures. Furthermore,

the long-term outcomes and neurodevelopmental sequelae of NP remain areas of ongoing research and debate.

National data from Libya and other developing countries regarding neonatal pneumothorax (NP) were quite limited. Consequently, we are conducting a retrospective study to describe the incidence, predisposing factors, complications, and outcomes of NP. Our rationale is to provide local data on this condition that might help in building an informative national registry toward establishing standardized targeted care for the neonatal population at risk.

Methods

Study population and inclusion/exclusion criteria

This study is a retrospective descriptive analysis. Following approval from the local authority, the medical records of all neonates admitted to the neonatal unit at a city hospital in Derna/Libya from January 2016 to December 2021 were examined. Patients diagnosed with pneumothorax were identified through a search of the neonatology department's patient database. Hospital charts and chest X-rays were then retrieved. A general surgeon reviewed all investigations. Only patients exhibiting symptomatic pneumothorax were included, while neoates with significant cardiac anomalies, renal failure, and other known causes of SpO2 decline (such as congenital diaphragmatic hernia) were excluded. The total count of admitted cases during this period is documented as 2871.

Independent variables, predisposing factors and outcomes of interest

Patients were assessed for baseline characteristics, including gestational age, gender, birth weight, and mode of delivery, as well as underlying pulmonary conditions such as respiratory distress syndrome (RDS), transient tachypnea of the newborn (TTN), and pneumonia. The timing of pneumothorax occurrence, laterality, treatment intervention (including drainage methods such as needle aspiration, tube thoracostomy (TT)), time to resolve, outcomes (survival or mortality) and associated illnesses include the length of stay were also examined.

Assumed predisposing factors

Maternal and neonatal characteristics that could lead to pneumothorax were identified and extracted from the database. These data included: Gestational age, birth weight, sex, Apgar score at one and five minutes, caesarean section (CS), prolonged rupture of membrane (PROM) >24h, antenatal steroid administration, the need for bag-mask ventilation (BMV), use of continuous positive airway pressure (CPAP) or noninvasive positive pressure ventilation (NIPPV), mechanical ventilation (MV), RDS and other underlying lung disease such as atelectasis and meconium aspiration, early and late-onset sepsis.

Data analysis

The incidence of neonatal pneumothorax cases per 1000 births was calculated. Descriptive statistical methods, including frequencies and percentages, were utilized to outline the incidence of neonatal pneumothorax cases.

Ethical considerations

This study adheres to ethical guidelines, prioritizing patient confidentiality and data security. Institutional review board approval has been obtained, and the research aligns with the principles outlined in the Declaration of Helsinki.

Results

Incidence of pneumothorax

Of a total live birth of 17,464 newborns during the study period, 2,887 neonates were admitted to level three NICU of whom 24 neonates (17 term and 7 preterm) were diagnosed with neonatal pneumothorax and met the inclusion criteria, giving an overall incidence of 1.37% and 8.3% among the hospitalized sick neonates admitted to NICU.

Predisposing factors

Our study included 24 subjects, and the mean maternal age was 24 ± 5 with 18 mothers (75%) having caesarean section delivery and 6 (25%) having normal spontaneous vaginal delivery (NVD). The mean gestational age was 37 ± 4 weeks (33-41). 25% of the mothers had steroid injections during the third trimester. The included neonates were 17 males and 7 females with a percentage (70%, and 30%, respectively). Most of the neonates were between 2500-2999 g (58%), three neonates were between 1,500 and 2,499 g. (12.5%), and no

neonate had a low or extremely low birth weight (<1500g). The average one-minute Apgar score was 7 ± 2 and the five-minute APGAR score was 8 ± 1 (Table 1).

Table 1: Baseline characters of the newborns diagnosed with pneumothorax (n=24). PROM: Premature rupture of membrane; CS: Caesarean section; NVD: Normal vaginal delivery.

Parameter		**Number (%)**
Maternal age, years		24±5 (19-29)
PROM		1 (4.1)
Steroid use		6 (25)
Mode of delivery	NVD	6 (25)
	C-Section	18 (75)
Gender	Female	7 (29)
	Male	17 (71)
Age	Term	17 (71)
	Preterm	7 (29)
Singleton or twin birth	Singleton	22 (91.6)
	Twin	2 (8.3)
Birth Weight (gram)	<1000	0
	1000-1499	0
	1500- 2499	3 (12.5)
	2500-2999	14 (58.3)
	3000-3500	3 (12.5)
	>3500	4 (16.6)
1 Minute APGAR Score	7 to 10	15 (62.5)
	4 to 6	4 16.6)
	0 to 3	5 (20.8)
Resuscitation		3 (12.5)
Ventilatory support		0

In summary, the data suggests that respiratory distress syndrome and thoracic air leak are the most prevalent predisposing factors for neonatal pneumothorax in the study population, each accounting for 25% of the cases. On the other hand, conditions such as asphyxia, pneumonia, and sepsis each account for only around 4% of the cases, making them the least common predisposing factors in this dataset (Table 2).

Table 2. Frequency and percentage distribution of various conditions associated with neonatal pneumothorax.

Condition	**Frequency**	**Percentage**
Asphyxia	1	4.1%
Respiratory distress syndrome (RDS)	6	25%
Meconium aspiration syndrome (MAS)	2	8.3%
Congenital malformations	4	16.6%
Pneumonia	1	4.1%
Sepsis	1	4.1%
Transient tachypnea of the newborn (TTN)	2	8.3%

Thoracic air leak	6	25%
Bag-Mask Ventilation (BMV)	2	8.3%
Mechanical Ventilation (MV)	-	-
Continuous Positive Airway Pressure (CPAP)	-	-
None	6	25%

The description of pneumothorax, management with an overall survival rate of 62.5% is presented in Table 3. The majority of cases (87.5%) had an onset of neonatal pneumothorax within the first 24 hours after birth, while a smaller proportion (12.5%) occurred after 24 hours. The time taken for resolution of pneumothorax ranged from 2 to 48 hours, with an average of 16 hours and a standard deviation of 4 hours. Chest tube insertion was the primary treatment modality employed in all cases (100%), while needling was not utilized. Pneumothorax was unilateral in all cases (100%), with no instances of bilateral involvement. Most neonates with pneumothorax survived (79.2%), while a smaller proportion (20.8%) did not survive. Additionally, 12.5% of cases were transferred to another hospital for further management.

Table 3: Characteristics and outcomes of neonatal pneumothorax

Parameter		**Frequency (%)**
Onset	< 24h	21 (87.5)
	> 24h	3 (12.5)
Time resolved in hours		16 ± 4 (2-48)
Treatment of Air leak	Chest tube	24
	Needling	-
Site	Unilateral	24
	Bilateral	0
Survival	Yes	19
	No	5
Transferred to another hospital		3 (12.5)
Duration of hospital stay (days)		3 (1-10)

Among the total death cases (3 out of 24), all occurred in neonates delivered via caesarean section without any cases from normal vaginal delivery. Most survived neonates were male (66.6%), while deceased neonates were mostly female (8.3%).

Two of the deceased neonates were born at term, with birth weights ranging from 2.6 to 2.9 kg, while one was a late preterm neonate weighting 2 kg. Survived neonates had 1-minute APGAR scores ranging from 4 to 10, while deceased neonates had scores between 7-8. Contributing factors to mortality included the presence of cyanotic congenital heart disease (CHD) in one case and intraventricular haemorrhage (IVH) and asphyxia in another. A small percentage of survived neonates required resuscitation (20.8%), while none of the deceased neonates required resuscitation. Deceased neonates had associated comorbidities including intraventricular haemorrhage (1 case), asphyxia (1 case), and cyanotic heart disease (1 case). These comorbidities were not observed in survived neonates except for cyanotic heart disease (3 cases), as shown in table 4.

Table 4: Subgroup analysis comparing survived and deceased neonates with pneumothorax.

Characteristic	Outcome	
	Survived Neonates (n=21)	**Deceased Neonates (n=3)**
Mode of Delivery		
Caesarean Section	15 (62.5)	3 (12.5)
Normal Vaginal Delivery	6 (25)	0
Gender		
Male	16 (66.6)	1 (4.1)
Female	5 (20.8)	2 (8.3)
Age		
Term Birth	15 (62.5)	2 (8.3)
Preterm Birth	6 (25)	1 (4.1)
Birth Weight (kg)		
1.5-2.4 kg	2 (66.7)	1 (33.3)
2.5-2.9 kg	12 (85.7)	2 (14.2)
1 minute APGAR score	4-10	7-8
Resuscitation	5 (20.8)	0
Associated comorbidities		
Intraventricular Haemorrhage	0	1
Asphyxia	0	1 (4.1)
Cyanotic heart disease	3 (12.5)	1 (4.1)

Discussion

The study aimed to investigate the incidence, predisposing factors, survival, and outcomes associated with neonatal pneumothorax (NP). The overall incidence of NP was found to be 1.37% in the total population of live birth during this study period. The incidence is higher in hospitalized sick neonates admitted to NICU (8.3%). Both of these incidences are in line with the worldwide incidence reported in the literature ranges between (0.5% - 3%) and (1.5% to 20%); respectively. The differences in the documented prevalence of NP may stem from various factors, including the characteristics of the neonatal population, disparities in the epidemiological and clinical profiles across different institutions, and the approach to management, particularly during the initial resuscitation period following delivery [12-14]. Male gender, low birth weight, preterm birth, delivery via cesarean section, and the presence of underlying lung conditions such as respiratory distress syndrome (RDS) and meconium aspiration requiring postnatal resuscitation have been identified as common predisposing factors for neonatal pneumothorax (NP) in previous studies [5,8, 15-18]. In contrast to the typical predisposing factors reported in previous studies, our findings diverge in several key aspects. Firstly, while male gender is commonly associated with neonatal pneumothorax, our study observed a higher proportion of deceased neonates being female (8.3%). Additionally, the deceased neonates in our study were predominantly born at term, with birth weights ranging from 2.6 to 2.9 kg, and one late preterm neonate weighing 2 kg. This contradicts the expectation of low birth weight and preterm birth as predisposing factors for neonatal pneumothorax. Furthermore, while survived neonates exhibited a wider range of one-minute Apgar scores (4 to 10), deceased neonates had scores between 7 and 8, suggesting a relatively better initial condition at birth. Contributing factors to mortality included the presence of cyanotic congenital heart disease (CHD) in one case and intraventricular hemorrhage (IVH) and asphyxia in another, highlighting the complex interplay of various comorbidities in determining outcomes. Interestingly, a small percentage of survived neonates required resuscitation (20.8%), while none of the deceased neonates re-

quired resuscitation. Moreover, deceased neonates had associated comorbidities such as intraventricular hemorrhage, asphyxia, and cyanotic heart disease, which were not observed in survived neonates except for cyanotic heart disease. These findings underscore the heterogeneity and complexity of neonatal pneumothorax and emphasize the need for further research to better understand its pathophysiology and predictors of adverse outcomes.

Predisposing factors such as respiratory distress syndrome (RDS) and thoracic air leak were prevalent, while conditions like asphyxia, pneumonia, and sepsis were less common. The majority of neonates diagnosed with NP were delivered via caesarean section, with most being male and born at term with a birth weight between 2.5-2.9 kg. Survival analysis revealed that 79.2% of neonates with NP survived, with mortality primarily associated with comorbidities such as cyanotic congenital heart disease (CHD) and intraventricular haemorrhage (IVH). Resuscitation was required in a small percentage of survived neonates, while none of the deceased neonates required resuscitation. These findings are consistent with previous studies highlighting the same outcome associated with IVH as the most commonly associated comorbidities [19,20]. Overall, the study provides valuable insights into the epidemiology, clinical characteristics, and outcomes of neonatal pneumothorax, underscoring the importance of timely identification and management of risk factors to improve outcomes in affected neonates.

The study's findings indicate that neonatal pneumothorax (NP) predominantly occurred within 24 hours of birth, with a small percentage occurring later. The average time for resolution was 16 hours, with a range of 2 to 48 hours. Treatment primarily involved chest tube placement, with no instances of needling reported. NP was predominantly unilateral, with no cases of bilateral occurrence. In contrast to the literature, survival rates were relatively high, with 19 cases resulting in survival and 5 cases resulting in mortality. The mortality rate was reported to be relatively high in all previous studies ranging from 20-38% [17, 21-24]. A portion of the patients (12.5%) was transferred to another hospital. The average duration of hospital stay was 3 days, ranging from 1 to 10 days. In general, all our surviving neonates had full recovery at discharge and without major neonatal morbidities.

The subgroup analysis comparing survived and deceased neonates with pneumothorax reveals notable differences in characteristics. Survived neonates were predominantly delivered via Caesarean section, male, of term birth, and had higher birth weights, particularly in the 2.5-2.9 kg range. Fewer required resuscitation and had fewer associated comorbidities. In contrast, deceased neonates were all delivered via caesarean section, predominantly female, with lower birth weights, especially in the 1.5-2.4 kg range. They also had a higher incidence of associated comorbidities, including intraventricular haemorrhage and asphyxia. These findings highlight potential associations between mode of delivery, gender, birth weight, and comorbidities with neonatal survival in cases of pneumothorax, warranting further investigation.

Conclusion

This study provides valuable insights into neonatal pneumothorax (NP) in a Libyan neonatal unit, shedding light on its incidence, predisposing factors, and outcomes. NP predominantly occurred within 24 hours post-birth, with respiratory distress syndrome (RDS) and thoracic air leak identified as common predisposing factors. Despite the challenges posed by NP, the study reports a relatively high survival rate of 79.2%, with mortality primarily associated with comorbidities such as cyanotic congenital heart disease (CHD) and intraventricular hemorrhage (IVH). Timely identification and management of NP and its associated risk factors are emphasized to improve outcomes in affected neonates. Moving forward, further research is warranted to validate these findings and explore potential associations in greater detail, thereby enhancing our understanding and management of NP in neonatal care settings.

Study limitations

While this approach offers valuable insights into the characteristics and outcomes of neonatal pneumothorax cases, it is susceptible to inherent limitations associated with retrospective data collection. Such limitations may include incomplete or missing data, variations in documentation practices over time, and potential biases in data selection and interpretation. Additionally, the study's reliance on medical records may limit the depth of information available for analysis, particularly regarding certain predisposing factors and outcomes of interest. Therefore, while the study provides important insights, caution should be exercised when interpreting the findings, and further prospective studies may be warranted to validate the results and explore potential associations in greater detail.

References

1. Ringer SA. Part 3: pneumothorax and air leak. In: Hansen AR, Puder M, editors. 2002 Manual of neonatal surgical intensive care. 2nd ed. Shelton: People's Medical Publishing House; 2009. p. 188–190.
2. Duong HH, Mirea L, Shah PS, et al. Pneumothorax in neonates: trends, predictors and outcomes. J Neonatal Perinatal Med. 2014;7(1):29–38.
3. Ali R, Ahmed S, Qadir M, et al. Pneumothoraces in a neonatal tertiary care unit: case series. Oman Med J. 2013;28(1):67–69.
4. Smith J, Schumacher RE, Donn SM, Sarkar S. Clinical course of symptomatic spontaneous pneumothorax in term and late preterm newborns: report from a large cohort. Am J Perinatol 2011;28:163-8.
5. Girard I, Sommer C, Dahan S, Mitanchez D, Morville P. Risk factors for developing pneumothorax in full-term neonates with respiratory distress. Arch Pediatr 2012;19:368-73.
6. Terzic S, Heljic S, Panic J, Sadikovic M, Maksic H. Pneumothorax in premature infants with respiratory distress syndrome: focus on risk factors. J Pediatr Neonatal Individ Med 2016;5:e050124.
7. Kitsommart R, Martins B, Bottino MN, Sant'Anna GM. Expectant management of pneumothorax in preterm infants receiving assisted ventilation: report of 4 cases and review of the literature. Respir Care 2012;57:789-93.
8. El-Masry H, Aladawy MA, Sayed Younis MM, Mahmoud DH. Risk factors for pneumothorax in ventilated neonates admitted to neonatal intensive care unit (NICU). Ann Neonatol J 2021;3:70-87.
9. Ozer EA, Ergin AY, Sutcuoglu S, Ozturk C, Yurtseven A: Is pneumothorax size on chest x-ray a predictor of neonatal mortality?. Iran J Pediatr. 2013, 23:541-5.
10. Zhang X, Zhang N, Ren YY: Review of risk factors, clinical manifestations, rapid diagnosis, and emergency treatment of neonatal perioperative pneumothorax. World J Clin Cases. 2022, 26:12066-6.
11. Santos Silva I, Flôr-de-Lima F, Rocha G, et al.: Pneumothorax in neonates: a level III Neonatal Intensive Care Unit experience. J Pediatric Neonatal Individ Med. 2016, 5:e050220.
12. Vibede L, Vibede E, Bendtsen M, Pedersen L, Ebbesen F: Neonatal pneumothorax: a descriptive regional Danish study. Neonatology. 2017, 111:303-8.
13. Park SW, Yun BH, Kim KA, Ko SY, Lee YK, Shin SM: A clinical study about symptomatic spontaneous pneumothorax. Korean J Perinatol. 2006, 17:304-9.
14. Aly H, Massaro A, Acun C, Ozen M: Pneumothorax in the newborn: clinical presentation, risk factors and outcomes. J Matern Fetal Neonatal Med. 2014, 27:402-6.
15. Kim E-A, Jung J-H, Lee S-Y, et al.: Neonatal pneumothorax in late preterm and full-term newborns with respiratory distress: a single-centre experience. Neonatal Med. 2022, 29:18-27.
16. Hadzic D, Skokic F, Husaric E, Alihodzic H, Softic D, Kovacevic D: Risk factors and outcome of neonatal pneumothorax in Tuzla Canton. Mater Sociomed. 2019, 31:66-70.
17. Esme H, Doğru O, Eren S, Korkmaz M, Solak O: The factors affecting persistent pneumothorax and mortality in neonatal pneumothorax. Turk J Pediatr. 2008, 50:242-6.
18. Abdellatif MA, Abdellatif DA: Pneumothorax in the neonatal intensive care unit in Cairo University Hospital. J Egypt Soc Parasitol. 2012, 42:495-506.
19. Hill A, Perlman JM, Volpe JJ. Relationship of pneumothorax to occurrence of intraventricular hemorrhage in the premature newborn. Pediatrics 1982; 69:144-9.
20. Ilçe Z, Gündogdu G, Kara C, Ilikkan B, Celayir S: Which patients are at risk? Evaluation of the morbility and mortality in newborn pneumothorax. Indian Pediatr. 2003, 40:325-8.
21. Ainsworth AP, Ruager AR, Holtved E: Neonatal pneumothorax (Article in Danish). Ugeskr Laeger. 2000, 4:6679-82.
22. Ilçe Z, Gündogdu G, Kara C, Ilikkan B, Celayir S: Which patients are at risk? Evaluation of the morbility and mortality in newborn pneumothorax. Indian Pediatr. 2003, 40:325-8.
23. Boo NY, Cheah IG: Risk factors associated with pneumothorax in Malaysian neonatal intensive care units. J Paediatr Child Health. 2011, 47:183-90.
24. Al Matary A, Munshi HH, Abozaid S, Qaraqei M, Wani TA, Abu-Shaheen AK: Characteristics of neonatal pneumothorax in Saudi Arabia: three years' experience. Oman Med J.2017,32:135-9.