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Pneumothorax Among Patients Admitted to A Pediatric Intensive Care Unit- A Retrospective Study

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ABSTRACT

Aims: *The objective of the study was to evaluate cases developing pneumothorax following admission to a Pediatric Intensive Care Unit (PICU) over a 5-year period.*

Settings and Design: *Case notes of all PICU patients (n = 1298) were reviewed, revealing that 135 cases (10.4%) developed pneumothorax.*

Results: *Patients with pneumothorax had higher mortality rate (P < 0.001), longer length of stay (P < 0.001), higher need for mechanical ventilation (MV) (P < 0.001), and were of younger age (P < 0.001), lower body weight (P < 0.001), higher pediatric index of mortality 2 score on admission (P < 0.001), higher pediatric logistic organ dysfunction score (P < 0.001)*

Conclusions: *This study demonstrated that pneumothorax is common in PICU patients*

KEYWORDS : Barotrauma, pneumothorax

Introduction

Pneumothorax is the accumulation of extrapulmonary air within the chest, most commonly from leakage of air from within the lung. Pneumothorax can be spontaneous or iatrogenic, with iatrogenic pneumothorax (IP) being more common worldwide.[1] In the USA, the incidence of spontaneous pneumothorax is approximately 7.4-18 cases per 100,000. [2] Pneumothorax in critically ill patients remains a common problem in the Intensive Care Unit (ICU, occurring in 4-15% of patients).[3,4]

The diagnosis of pneumothorax can be made by physical examination or imaging studies including chest X-ray, ultrasonography, and computed tomography (CT) scan.[5]

Pneumothorax is associated with prolonged length of stay (LOS), increased morbidity and mortality.[6] Most cases of pneumothorax are iatrogenic in origin caused by barotrauma secondary to mechanical ventilation (MV).[7] IP is related to underlying lung disease along with high ventilatory settings.[8]

This study aimed at evaluating the incidence of this complication in critically ill patients admitted (PICU) over a 5-year period, to determine its risk factors and diagnostic strategies, and to study its impact on the prognosis of these patients with an aim to prevent pneumothorax and improve its management.

Methodology:

This retrospective study was conducted in a PICU of a teaching hospital. All case notes of patients admitted between January 1, 2010, and December 31, 2014, were reviewed, and the following data were extracted: personal characteristics, age of the patient, diagnosis, outcome, pediatric index of mortality 2 (PIM2) score[9] on admission and pediatric logistic organ dysfunction (PELOD) score[10] on day 1, LOS in days, and MV parameters were studied.

Diagnosis depended on clinical suspicion. Clinically, cases presented with chest pain, respiratory distress, tachypnea, decrease or absent breath sounds, and absent chest movement on the affected side. Diagnosis was then approved by plain X-ray chest posteroanterior view (erect position) and CT chest. In all statistical tests, **$P \leq 0.05$ was adopted as the level of statistically significant.**

Results

This retrospective study included 1298 patients admitted to PICU over 5 years. It was found that 10.4% (*n* = **135) of patients developed 151 episodes of pneumothorax (Group 1) and the remaining patients 89.6% (***n*** = 1163) did not (Group 2).**

Table 1 **indicates that the pneumothorax group was of younger age and had lower body weight, higher PIM2 score, higher PELOD score on day 1, longer LOS, higher need for MV, higher likelihood of having an underlying respiratory disease, sepsis and septic shock, and higher mortality rate (*P* < 0.001,** *P* < 0.001,*P* **< 0.001,** *P* **< 0.001,** *P* **< 0.001,** *P* **< 0.001,** *P* **= 0.001,** *P* **= 0.007, and** *P* **< 0.001, respectively).**

Table 2

The clinical examination as the first diagnostic tool was helpful in the diagnosis of 27.2% of episodes of pneumothorax, and plain X-ray diagnosed 70.2% of cases. CT was used to detect pneumothorax in the remaining 2.6% of episodes. Ultrasonography was used to follow-up proper thoracocentesis and tube placement, rather than diagnosis.

Table 3 **shows a statistically significant difference between the two groups in terms of their MV data. The results indicate the longer duration of ventilation, higher conventional ventilation settings, and higher mean airway pressure in high-frequency oscillatory ventilation (HFOV) in the pneumothorax group (*P* < 0.001,** *P*< 0.001, and *P* **< 0.001 respectively).**

Discussion

In the present study, the prevalence of pneumothorax in PICU during the 5-year study was 10.4%. This was found to be within the range of pneumothorax reported in several studies (4-15%).[3,4]

In the present study, the mean LOS was 7 days longer in cases with pneumothorax compared with those without pneumothorax. Zhan *et al*. found that patients with pneumothorax usually have extra 4.4 days added to the LOS, an extra cost of $18000 US, and have a 6% higher risk of hospital death.[11] Hsu *et al*. demonstrated that in patients on MV, pneumothorax was associated with a significant increase in the ICU LOS and mortality rate.[8] The mortality rate was 59% in Group 1 compared to 10% in Group 2.

In the present study, high index of suspicion as the first screening tool was helpful in the diagnosis of 27.2% of episodes. Plain chest X-ray diagnosed 70.2% of cases and ultrasonography was used for follow-up. CT was used to detect 2.6% of episodes of pneumothorax. This corroborates with Wilkerson and Stone,[12] Rowan *et al*.[13] who reported that the plain radiograph is the primary radiological tool for screening for pneumothorax with a sensitivity of 80% in erect posture and 36-48% in the supine anteroposterior position. Ultrasonography has become more readily available at the bedside, and a recent liter-

ature review has reported a sensitivity of 86-98% and a specificity of 97-100% for diagnosing pneumothorax.[14] CT chest scanning is the gold standard test for both diagnosing and determines the size of pneumothorax[15]

Many investigators have emphasized that pneumonia is an important predisposing factor in the development of pulmonary barotrauma in mechanically ventilated patients.[16] Patients with other lung diseases such as severe acute respiratory syndrome have a high incidence of pneumothorax (20-34%) in mechanically ventilated patients.[17]

MV and CVC insertion accounted for more than 82% of episodes of pneumothorax, which is why tension pneumothorax represented 41.1% of pneumothorax episodes. Many investigators agreed that IP can also be induced by thoracic procedures or any procedures involving the neck.[5,14,18,19] Many researchers highlighted that pneumonia is an important predisposing factor in the development of barotrauma in ventilated patients.[16] A recent study revealed that duration of ventilation is thought to be a risk factor for developing barotraumas.[20]

The present study showed that conventional MV CMV, synchronized intermittent mandatory ventilation/pressure support represented the major starting modes of ventilation and that pressure control comes next. A number of studies have concluded that the incidence of barotrauma does not relate to ventilator mode.[21]

Conclusion

Firstly, pneumothorax is considered as a major complication associated with increased LOS, increased morbidity and mortality among PICU patients. Second, most cases of pneumothorax were iatrogenic caused by barotrauma and CVC insertion coming next.

Tables:

1. Comparison of personal and clinical characteristics on admission of cases with (Group 1) and without pneumothorax (Group 2)

Characteristics	Group 1 (n=135)	Group 2 (n=1163)	P
Age(mean month)	12.29±22.59	25.75±37.02	<0.0001*
Weight (kg)	6.88±5.29	10.14±7.87	<0.001*
Sex, n(%) Female Male	 71(52.6) 64(47.4)	 525(45.1) 638(54.9)	0.1
PIM2 score	39.82±29.61	27.88±25.64	<0.001
PELOD score day 1	11.89±9.78	9.22±8.93	<0.001*
Diagnostic category, n(%) Respiratory Sepsis and septic shock Others	 53(39.3) 47(34.8) 35(25.9)	 278(23.9) 280(24.1) 605(52)	 0.001* 0.007* 0.005*
Mechanical ventilation, n(%)	125(92.6)	614(52.8)	<0.001*
Fate, n(%) Discharged Decreased	 55(40.75) 80(59.25)	 1043(89.7) 120(10.3)	<0.001*
LOS (days)	13.48±12.39	6.44±8.95	<0.001*

PIM- Pediatric index of mortality, PELOD- pediatric logistic organ dysfunction

Table 2: Personal and clinical characteristics of cases with and without respiratory diseases on admission

Characteristics	Respiratory diseases (n=331)	Nonrespiratory diseases (n=967)	P
Age(mean month)	13.06±17.99	28.21±39.66	<0.0001*
Weight (kg)	7.92±4.53	10.45±8.43	0.005*
Sex, n(%) Female Male	 140(42.3) 191(57.7)	 456(47.2) 511(52.8)	0.126
PIM2 score	25.1±23.12	30.5±27.21	0.004*
PELOD score	6.38±6.06	10.57±9.65	<0.001*
Mechanical ventilation, n(%) Yes No	 234(70.7) 97(29.3)	 505(52.2) 462(47.8)	<0.001*
Fate, n(%) Discharged Decreased	 270(81.6) 61(18.4)	 828(85.6) 139(14.4)	0.336
LOS (days)	6.9±8.01	7.27±10.1	0.151
Pneumothorax (%) yes no	 53(16) 278(84)	 82(8.5) 885(91.5)	<0.001*

Table 3: Comparison of cases with and without pneumothorax as regard mechanical ventilation

	Group 1 (n=135)	Group 2 (n=1163)	P
Days of mechanical ventilation	12.24±11.73	4.46±8.19	<0.001*
Starting mode of ventilation SIM/PS SIM/VC PC VC HFOV CPAP	 66(52.8) 6(4.8) 32(25.6) 3(2.4) 18(14.4) 0	 403(65.7) 10(1.6) 83(13.5) 6(1.0) 39(6.3) 73(11.9)	<0.001*
	N=107	N=575	
Mean ventilator setting of conventional ventilation PEEP(cm H2O) PIP(cm H2O) Rate(cycle/min) FiO2(%)	 6.92±3.93 28.29±6.32 39.85±10.89 67.95±18.83	 5.31±1.79 19.56±5.22 33.35±7.35 52.03±12.82	 <0.001* <0.001* <0.001* <0.001*
	N=18	N=39	
Mean ventilator setting for HFOV Mean airway pressure(cm H2O) frequency (Hz) FiO2 (%)	 30.11±5.8 6.59±1.5 72.45±19.41	 25.33±7.71 5.95±0.94 53.7±14.82	 0.02* 0.145 <0.001*

References

1. Winnie GB. Pneumothorax. In: Kliegman RM, Behrman RE, Stanton BF, editors. Nelson Textbook of Paediatrics. 19th ed. Philadelphia: Saunders Elsevier; 2011. pp. 1835–7.
2. Eckstein M, Henderson S, Markovchick V. Thorax. In: Marx JA, editor. Rosen's Emergency Medicine: Concepts and Clinical Practice. 5th ed. St. Louis: Mosby; 2002. pp. 386–91.
3. Strange C. Pleural complications in the intensive care unit. Clin Chest Med. 1999;20:317–27.
4. de Latorre FJ, Tomasa A, Klamburg J, Leon C, Soler M, Rius J. Incidence of pneumothorax and pneumomediastinum in patients with aspiration pneumonia requiring ventilatory support. Chest.1977;72:141–4.
5. Rankine JJ, Thomas AN, Fluechter D. Diagnosis of pneumothorax in critically ill adults. Postgrad Med J. 2000;76:399–404.
6. Esteban A, Anzueto A, Frutos F, Alía I, Brochard L, Stewart TE, et al. Characteristics and outcomes in adult patients receiving mechanical ventilation: A 28-day international study. JAMA. 2002;287:345–55.
7. de Lassence A, Timsit JF, Tafflet M, Azoulay E, Jamali S, Vincent F, et al. Pneumothorax in the intensive care unit: Incidence, risk factors, and outcome. Anesthesiology. 2006;104:5–13.
8. Hsu CW, Sun SF. Iatrogenic pneumothorax related to mechanical ventilation. World J Crit Care Med.2014;3:8–14.
9. Flater A, Shann F, Pearson G. PIM2: A revised version of the pediatric index of mortality. Intensive Care Med. 2003;29:278–85.
10. Leteurtre S, Martinot A, Duhamel A, Proulx F, Grandbastien B, Cotting J, et al. Validation of the paediatric logistic organ dysfunction (PELOD) score: Prospective, observational, multicentre study. Lancet.2003;362:192–7.
11. Zhan C, Smith M, Stryer D. Accidental iatrogenic pneumothorax in hospitalized patients. Med Care.2006;44:182–6.
12. Wilkerson RG, Stone MB. Sensitivity of bedside ultrasound and supine anteroposterior chest radiographs for the identification of pneumothorax after blunt trauma. Acad Emerg Med. 2010;17:11–7.
13. Rowan KR, Kirkpatrick AW, Liu D, Forkheim KE, Mayo JR, Nicolaou S. Traumatic pneumothorax detection with thoracic US: Correlation with chest radiography and CT - Initial experience. Radiology.2002;225:210–4.
14. Johnson NN, Toledo A, Endom EE. Pneumothorax, pneumomediastinum, and pulmonary embolism.Pediatr Clin North Am. 2010;57:1357–83.
15. Yarmus L, Feller-Kopman D. Pneumothorax in the critically ill patient. Chest. 2012;141:1098–105.

16. Kumar A, Pontoppidan H, Falke KJ, Wilson RS, Laver MB. Pulmonary barotrauma during mechanical ventilation. Crit Care Med. 1973;1:181–6.
17. Lew TW, Kwek TK, Tai D, Earnest A, Loo S, Singh K, et al. Acute respiratory distress syndrome in critically ill patients with severe acute respiratory syndrome. JAMA. 2003;290:374–80.
18. Sassoon CS, Light RW, O'Hara VS, Moritz TE. Iatrogenic pneumothorax: Etiology and morbidity. Results of a Department of Veterans Affairs Cooperative study. Respiration. 1992;59:215–20.
19. Despars JA, Sassoon CS, Light RW. Significance of iatrogenic pneumothoraces. Chest.1994;105:1147–50.
20. Cullen DJ, Caldera DL. The incidence of ventilator-induced pulmonary barotrauma in critically ill patients. Anesthesiology. 1979;50:185–90.
21. Gammon RB, Shin MS, Groves RH, Jr, Hardin JM, Hsu C, Buchalter SE. Clinical risk factors for pulmonary barotrauma: A multivariate analysis. Am J Respir Crit Care Med. 1995;152(4 Pt 1):1235–40.