DISCUSSION

This retrospective study conducted in Alexandria University Pediatric Intensive Care Unit evaluated the pneumothorax affected children during 5 years (1st January 2008 to 31stDecember 2012) included 1298 admitted patients. In this group of patients, we tried to discuss the following questions on local and global basis:

First question: What is the epidemiology and incidence of pneumothorax among ICU patients locally and globally?

Pneumothorax in critically ill patients remains a common problem in the ICU, occurring in 4-15% of patients.[59,60] In a study of 869 patients in pediatric ICU, air leak occurred in 6-8% of patients.[61]

In the present study, the incidence of pneumothorax in admitted patients to Alexandria University PICU during the 5 year study was 10.4%.

Pneumothorax could be spontaneous or iatrogenic. The incidence of spontaneous pneumothorax in USA is 7.4-18/100000 boys and 1.2-6/100000 girls with a male to female ratio of 2:1. [8]**In the present study** spontaneous pneumothorax represented only 5% of total pneumothoraces and represented only 0.6% of total ICU patients in this study.

In the whole world, most of the pneumothorax patients in ICU were of the iatrogenic type. In a wide study, the cumulative incidence of iatrogenic pneumothorax (IP) among 3430 ICU patients was 3 %. [62] Iatrogenic pneumothorax (IP) occurs more common than the spontaneous type. [63] The incidence of IP in the ICU was greater than 20% in the 1990s[64] and since then, decreased to 3**%. In the present study,** IP represents 95% of all cases of pneumothorax and this represents 9.8% of all ICU admitted patients which is higher than the international reports. There are several reasons for that higher incidence. The first explanation is that the mean PIM2 score on admission is nearly 40 which represents a bad general condition on admission, the second cause is the high incidence of patients who needed mechanical ventilation in the studied group to be 57% of all admitted patients. All over the world the percentage of mechanically ventilated children in the ICU ranged from 30-64% [65-67] **. In the present study**, most of IP was due to barotrauma related to mechanical ventilation representing nearly 70% of all pneumothoraces, and 92.6% of all pneumothorax cases were mechanically ventilated while acquiring pneumothorax. This is contradictory to the results found in 33 PICU admissions in Spain and published in 2004, revealing that 45.5% of admitted cases needed mechanical ventilation and pneumothorax developed in 8.1% of mechanically ventilated patients [68]. **The present study** showed that 17% of ventilated patients (n=125/739) acquired pneumothorax. Other investigators revealed that the incidence of pneumothorax was as high as 7-14% of patients receiving mechanical ventilation.[69-71]

Iatrogenic pneumothorax incidence depends upon the procedures used in the ICU. In a recent review, it was found that 57% of the procedures that lead to IP at a teaching hospital were performed under emergent situations. The most frequent procedure type was central venous catheterization (43.8% of IP), thoracentesis (20.1%) and barotrauma due to mechanical ventilation (9.1%).[17] In another retrospective study conducted on adult ICU patients for 3 years, the etiological factors which caused IP were mechanical ventilation with positive pressure (35%), during resuscitation (27.1%), after central venous

catheterization (24.3%) and percutaneous tracheostomy (13.5%).[72] **In the present study**, IP occurred due to barotrauma related to mechanical ventilation (69.6% of pneumothorax cases), CVC insertion (13.2%), post –bronchoscope (0.67%) and others(11.9%) .

The incidence of tension pneumothorax (TPT)which is the severest form of pneumothorax, in a review in 2005 was 5.4% of major trauma patients.[29] Tension pneumothorax in one study, was found to be more common in ventilated patients, occurring in 30-97% of all pneumothorax cases .[73,74] Actually the exact incidence of TPT is unknown, but it is more common in ventilated patients.[75]**In the present study**, 41.1% of episodes of pneumothorax were TPT, and the overall mortality rate of the whole pneumothorax group was 59.25%.

Second question: What are the hazards and complications of acquiring pneumothorax in the ICU?

Pneumothorax in ICU represents a potentially life threatening event, particularly if associated with mechanical ventilation. [62] Pneumothorax was found to be an independent predictor of mortality during mechanical ventilation [76] and was associated with a significant increase in the ICU length of stay (LOS), hospital stay and mortality in all mechanically ventilated patients. The mortality rates are high ranging from 46-77% of barotrauma as a complication of mechanical ventilation.[77] A French study from 11 ICUs revealed that those who developed pneumothorax during the first 30 days of admission were more than twice as likely to die as those who did not .[62] Iatrogenic pneumothorax can be associated with significant mortality and may prolong the length of hospital stay, particularly if related to critical illness.[62] It has a two fold increase in the risk of death[62]and it leads to a longer length of stay in the ICU.[72] Pneumothorax patients usually have an extra 4.4 days added to the LOS, 18000 US dollars in addition and had a 6% higher risk of hospital death.[78] The most concerning adverse outcome of IP is progression to TPT which leads to rapid progression to cardiopulmonary collapse and death .[77]

In the present study, the mean LOS in PICU was 7 days, longer in cases with pneumothorax compared to those without (13.5 days vs 6.5 days) with a highly significant statistical difference. The deceased patients were 59% in pneumothorax patients compared to 10% in patients without pneumothorax with a highly significant statistical difference. Ninty-two percent (92%) of patients with pneumothorax were mechanically ventilated while only 52.8% of patients without pneumothorax did so. Mechanical ventilation had lead to episodes of pneumothorax, of them 41.1% were TPT due to progressive air leak from mechanical ventilation.

The Kaplan –Meier survival curve revealed that most of the mortality occurred within a LOS of 30 days in patients without pneumothorax compared to 50 days in patients with pneumothorax with a statistically significant difference regarding mortality and LOS.

Third question: What are the etiological and risk factors for acquiring pneumothorax in ICU?

Risk factors of iatrogenic pneumothorax in an adult study were; a body weight <80 kg, a history of adult immunodeficiency syndrome, diagnosis of acute respiratory distress syndrome (ARDS), central vein or pulmonary artery catheter insertion and use of inotropic agents during the first 24 hours.[72] Moreover, another study added that IP in an adult ICU

occurs chiefly as a barotrauma related to mechanical ventilation or as a post-procedural event (eg: after central venous catheter insertion and thoracentesis surgery). Also, the occurrence of IP is closely related to the underlying disease as ARDS.[62]

Different investigators added that all invasive pleural procedures have the potential to cause harm. IP can be induced by thoracic procedures or any procedures involving the neck.[79-81]

Concerning respiratory diseases, many investigators stressed that pneumonia is an important predisposing factor in the development of pulmonary barotrauma in mechanically ventilated patients.[82] The same risk factors occurred in chronic obstructive pulmonary diseases and ARDS ventilated patients who have a higher incidence of pneumothorax.[83]

Other lung diseases as severe acute respiratory syndrome (SARS), demonstrates a high incidence of pneumothorax (20-34%) among mechanically ventilated cases.[84] One study showed 4% incidence of pneumothorax among patients with cystic fibrosis, with 35% mortality for those acquiring pneumothorax, also there is a higher incidence of infection with pseudomonas aeruginosa in cases with cystic fibrosis (82% in cases with pneumothorax).[85]

A recent study revealed that in an adult ICU, duration of ventilation is thought to be a risk factor to develop a barotrauma.[86]

In the present study, age was a risk factor, as the pneumothorax was found to occur at significantly younger age 12 months vs 26 months in those without pneumothorax .Also pneumothorax occurred at lower body weight (6.88Kg vs 10.14Kg in non –pneumothorax group), worse general conditions on admission as shown with high PIM2 score as compared to patients without pneumothorax (39.82% vs 27.88%). The LOS was significantly longer in pneumothorax cases compared to those without pneumothorax (13.5 days vs 6.5 days). The risk factor in diagnostic category of disease on admission was significantly higher in cases with pneumothorax especially respiratory diseases (39.4% vs 23.9%), sepsis and septic shock (34.8% vs 24.1%). Mechanical ventilation and CVC insertion account for more than 82% of episodes of pneumothorax, that is why TPT represents 41.1% of pneumothorax episodes **in the present study**.

Comparing different laboratory data values in cases with pneumothorax, in the present study, on the day of admission to the day of occurrence of pneumothorax revealed many alarming indicators, they are not considered as risk factors, but rather alarming criteria. Comparing the day of admission parameters to those of the pneumothorax day, it was found, **in the present study**, that the PELOD score significantly increased, the pH became significantly lower, more acidotic (7.39vs 7.24), the P_aCO_2 was significantly higher (42 vs 64) and the patient got more hypoxemic: P_aO_2 (74 vs 59) and S_aO_2 (91% vs 81%).So, when we evaluate ICU patients, it should be emphasized that these worsening parameters could be due to complications especially pneumothorax.

Respiratory diseases, **in the present study**, are a group of risk factors because the incidence of mechanical ventilation was significantly higher than those with non-respiratory diseases (70.7%vs 52.2%) and the incidence of pneumothorax was significantly higher (16% vs 8.5%).

It has to be mentioned that a multiple logistic regression model revealed that the risk factors that predict pneumothorax were peak inspiratory pressure (PIP), FiO_2, P_aCO_2 and HCO_3.

It is pertinent to mention that there are risk factors for misdiagnosis of pneumothorax in the ICU including: ventilation, unusual location of pneumothorax, changed patient mental status and lack of senior medical cover at the time of presentation. (29)

Forth question: What is the relation of mechanical ventilation to pneumothorax in ICU? How can we prevent pneumothorax in mechanically ventilated patients?

Mechanical ventilation of patients with diseases of increased airway resistance should center on avoidance of dynamic hyperinflation, allowing complete exhalation prior to the initiation of a subsequent breath and permissive hypercapnia. (87) Mechanical ventilation of patients with abnormal lung compliance should take into consideration the inhomogeneous distribution of lung disease. Focus should be on avoidance of volutrauma and atelectrauma that could result in ventilator –associated lung injury.(87)

Mechanical ventilation can no longer be viewed simply as a harmless support modality that is employed to keep patients alive while disease-specific treatments are used to ameliorate the underlying pathology.(87)

Pneumothorax is a potentially lethal complication associated with mechanical ventilation. Pneumothorax is rare in intubated patients with normal lungs. Tension pneumothorax is more common in ventilated patients. Underlying lung diseases are associated with ventilator–related pneumothorax with pneumothoraces occurring most commonly during the early phase of mechanical ventilation. (77)

An earlier study in the pediatric population showed that the prevalence of pneumothorax in ventilated patients was significantly higher in the era before "protective lung strategies" with low tidal volume were the standard of care.(88)

Table (11): key features of protective lung ventilation.(89)

Key features of lung protective ventilation:

- Controlled oxygen exposure (FiO_2 <0.6)
- Permissive hyper-carpia (pH > 7.25)
- Low tidal volume (4-6 ml/Kg)
- Adequate PEEP
- Peak pressure < 30 cmH_2O

In the present study, protective lung strategies were applied mostly .We should remember that we discuss here three situations for mechanical ventilation: normal lung, lung with diseases affecting airway resistance mostly and lungs with diseases affecting the compliance mostly. Again, two types of ventilation were used; conventional mechanical ventilation (CMV) and high frequency oscillatory ventilation (HFOV). In each type of ventilation different settings were used and has to be discussed.

Pneumothorax, as a complication of mechanical ventilation, is mostly iatrogenic. Most of these cases have lung diseases ranging from primary obstructive lung disease to secondary pneumonia and ARDS.

In the present study, 22.6% of patients with respiratory diseases (n=53/234) who were on mechanical ventilation developed pneumothorax, while patients without respiratory diseases only 16% of those who needed mechanical ventilation developed pneumothorax.

The patients on CMV represented 80%of pneumothorax cases while, HFOV represented only 13% of cases of pneumothorax. All cases on HFOV were cases of ARDS. All ARDS cases were on HFOV and only 31% of them developed pneumothorax.

A Turkish study published in 2006, of three years (2002-2005) of follow up of PICU patients revealed that the percentage of mechanically ventilated patients was 22.3%. They found that 13.1% of mechanically ventilated patients developed pneumothorax,[90] while in the present study 17% of mechanically ventilated patients develop pneumothorax.

Different studies showed that the incidence of barotrauma in mechanically ventilated patients was 4-16%.[59,64,73,83]While in the present study the incidence of pneumothorax was 10%. They reported also that the incidence of pneumothorax depends on the severity and duration of ARDS and ventilator management.[77]Others reported that the incidence of IP is the highest in acute lung injury and ARDS patients.[62]

Concerning CMV, several reports have implicated positive-pressure ventilation with or without positive end expiratory pressure (PEEP) as an important cause of pulmonary barotrauma in adult patients receiving mechanical ventilation, the incidence of barotrauma ranges from 4-18% depending on the type of ventilator used, level of PEEP and the disease process.[60,82] On the contrary, others who advocate the use of high level of PEEP (>18 torr in adults) report an incidence of pneumothorax of 7-14%, claiming that the incidence is not greater than those associated with or without conventional ventilation.[92,93] Kirby et al[93]reported that pneumothorax developed in 14% of adult patients with PEEP>18torr. Several studies have found no such relationship between high PEEP and development of pneumothorax.[74,82,86,94] **In the present study**, there was a significantly high level of PEEP in mechanically ventilated cases that acquire pneumothorax compared to those who did not.

In adults, peak inspiratory pressure (PIP) over 50 cmH_2O is associated with increased risk of alveolar rupture during mechanical ventilation.[64]There has been a correlation between high (PIP) and pneumothorax.[95,96]Shearing forces from positive pressure ventilation may result in the development of bronchopleural fistula which can quickly enlarge due to continuous pressure from the ventilator and may result in TPT.[92]Different studies from the literature, on the other hand, showed that the incidence of barotrauma did not relate to the ventilator settings [83, 97, 98]. **In the present study**, peak inspiratory pressure (PIP) was significantly higher in cases with pneumothorax compared to those without pneumothorax. The mean PIP was <30cmH_2O which is within the accepted range in the new protective lung strategies.

Different investigators, in a published review revealed that barotrauma is not due to pressure of mechanical ventilation but rather due to volume which causes alveolar damage,

thus it is now called volutrauma.[72] Others added that increased pressure is not enough to produce alveolar rupture, but rather it is related to high tidal volume.[94]

As regards ventilator mode, **in the present study,** it was found that in CMV, synchronized intermittent mandatory ventilation with pressure support (SIMV/PS) represented the major starting mode of ventilation and pressure control (PC) comes next. The starting modes CMV among pneumothorax patients were statistically different from those of patients without pneumothorax. It seems from different studies in the literature that the incidence of barotrauma did not relate to ventilator mode.[83,97,98] It is suggested that low lung compliance was associated with a high incidence of barotrauma which suggested that barotrauma has been more related to the underlying lung disease than to the ventilator settings.[77]

Approximately, in a publication, it was found that 7.4-10% of patients with first episode of pneumothorax will develop a second episode of pneumothorax on the other lung during mechanical ventilation [83]**. In the present study**, 11.8%of patients develop a second episode of pneumothorax (135 patient had 151 episode of pneumothorax).

As regards high frequency oscillatory ventilation (HFOV), it was applied to all cases of ARDS, while 31.5% of them developed pneumothorax in spite of that. ARDS, a heterogeneous disease in which the lung is physiologically small with a low compliance.[99] The dependent lung regions tend to be collapsed and the lung regions subject to high pressure over-inflation and alveolar rupture are non –dependent regions when positive end expiratory pressure(PEEP) inflates and recruits some of the collapsed regions during mechanical ventilation. [100,101] Moreover, sub-pleural and intra-pulmonary air cysts occur in ARDS patients and the rupture of these air cysts may be the cause of pneumothorax. Whether the pneumothorax in ARDS arises from over-inflation of normal lung regions or from cyst rupture has not yet been conclusively established. [102]Risk factors for developing ARDS include: sepsis, gastric aspiration, pulmonary contusion, multiple transfusions, pneumonia, multiple fractures, inhalational injury, burns, acute pancreatitis, drug overdose and shock.[103]

In a pediatric ICU, study of ARDS ventilated cases in the pre-protective lung strategy era (1992-1994) revealed a 55% incidence of pneumothorax compared to 17% incidence of pneumothorax in the post-protective lung strategy era (2000-2003).[88] **In the present study**, we used HFOV mode as a protective lung strategy, the incidence of pneumothorax was 31.1%of all ARDS ventilated patients.

The protocol adapted and accepted widely that we used in ARDS patients on HFOV is the following: a mean airway pressure (Maw) >2-5 cmH_2O above the Maw of CMV. The Maw is to HFOV as peak inspiratory pressure in CMV. A pneumothorax that can result from HFOV is due to high Maw. Optimal pressures can be defined as the amount of pressure necessary to ventilate adequately and maintain normal P_aCO_2. Intial FiO_2 is 1.0, amplitude (ΔP) is adjusted to achieve adequate pressure for chest wall vibration and airflow maintained at 30ml/min. The intial oscillatory frequency is adjusted to 7-15Hertz (Hz) according to the body weight (frequency in HFOV is equal to respiratory rate in CMV), (one hertz equals 60 cycle per minute). The two main factors determining ventilation are frequency (Hz) and amplitude (Deltap, ΔP). DeltaP is the pressure fluctuation relative to the Maw creating sinusoidal pressure fluctuations relative to the Maw. Frequency determines the number of oscillations of deltaP per unit time. At lower

Hz the ventilator is able to achieve most of the delta P thereby generating effective ventilation and lowering P_aCO_2. As the Hz increases the oscillator is unable to to achieve the full deltaP, sinusoidal wave of airway pressure is essentially dampened, reducing the size of the breath resulting in less effective ventilation. Therefore keeping the delta P constant and decreasing the Hz will increase ventilation, and increasing the Hz will decrease ventilation due to dampening, making each delta p less effective. To attain HFOV weaning, FiO_2 was kept between 0.4and 0.6, followed by a decrease of 1 to 2 cmH_2O to of mean airway pressure. Regarding ventilation, there was progressive reduction in amplitude pressure (3-5cmH_2O). CMV could be resumed when mean airway pressure was <20 cmH_2O, FiO2≤ 0.4 and when the patient tolerates the aspiration through the endotracheal tube without oxygen saturation decreases.(104)

Monitoring of HFOV is done at the beginning and after 6,12,24,48 hours by monitoring: Maw, amplitude, respiratory rate, FiO_2, oxygenation index (OI)($FiO_2 \times Maw/P_aO_2$) and P_aO_2/ FiO_2 ratio calculated. Besides hemodynamic parameters are obtained simultaneously (mean arterial pressure MAP, heart rate and inotropic score).(105)

In the present study, Maw was significantly higher in cases with pneumothorax compared to those without pneumothorax in ARDS patients. It should also be noted that on the day of pneumothorax, all pneumothorax patients had a significantly higher P_aCO_2 and this means that in cases of HFOV the delta p was not fixed but rather the Hz, which is the opposite of what ought to be, as decreasing the Hz with a constant ΔP will lead to a proper ventilation.

Fifth question: How can we detect and diagnose pneumothorax as early as possible in an ICU setting?

To diagnose pneumothorax in PICU, we are confronted with two major issues:

1) The rapidity with which we need urgent and instantaneous diagnosis and intervention.
2) The inability to move a mechanically ventilated infant who is hemo-dynamically unstable and moving him may jeopardize his life.

For these reasons we have to do our best to diagnose pneumothorax inside the ICU. So, the question is what are the clues that let us suspect the presence of pneumothorax:

- **Clinical suspicion:**

The diagnosis of pneumothorax can sometimes be made from history and physical examination, noting acute onset of dyspnea or chest pain, tachycardia, hypotension, decreased breath sounds, pulsus paradoxsus and contralateral tracheal deviation. Many of these findings are non- specific.(28)

It should be noted that a small pneumothorax(<15% of a hemithorax) probably has normal physical examination.(77)

During mechanical ventilation, a sudden reduction in tidal volume during pressure controlled ventilation or increased airway pressure with volume controlled ventilation may be found from ventilator display.(77)

In the present study, the clinical suspicion as the first diagnostic tool was helpful in the diagnosis of 27% of episodes of pneumothorax.

- **Plain Radiography:**

In critically ill children, the traditional erect postero-anterior expiratory films is not practical and thus the supine or semi-recombinant antero-posterior film is frequently obtained.[28] There may be the classic finding of lung collapse in or around the apices, or in the supine posture air collects in a subtle fashion along the anterior space without a clear lung edge finding. As additional air accumulates , it can track further around the chest and results in the classic deep sulcus sign.[28] The plain radiograph or chest x-ray is the primary radiological tool to screen for pneumothorax with a sensitivity of 80% in erect posture but supine antero-posterior chest x-ray has a sensitivity of 36-48%.[106,107]

In the present study, plain chest x-ray diagnosed 70% of pneumothorax cases as the PICU is equipped with a portable x-ray and instantaneously developer of the film to get the results in no time.

- **Ultrasonography:**

Ultrasonography became more readily available at bedside and a recent literature review reported a sensitivity of 86-98%and specificity of 97-100% of ultrasonography for diagnosing pneumothorax.[81]

In the present study, despite that the unit is equipped with an updated Echo-Doppler-ultrasonography machine, we used ultrasonography rather to follow up proper thoracocentesis and tube placement .We did not use it as primary tool for diagnosis.

- **Computerized Tomography scan(CT Scan);**

It is the gold standard test for both diagnosing and sizing of pneumothorax.[28] The inconvenience of moving the patient to do CT and the cost must be considered.

In the present study, CT was used to detect pneumothorax in 2.6% of episodes of pneumothorax.

It seems that clinical suspicion and plain radiology were able to detect >97% of episodes of pneumothorax. If any ICU is able to add a portable ultrasonography, that will help diagnosing majority of the cases. CT scan would be left to evaluate difficult cases as diagnosis and follow up.

Sixth question: What can we conclude from this study? What can we recommend?

From the present study we conclude

- Pneumothorax is a major complications occurring in PICU and is associated with prolonged length of stay, increased morbidity and mortality.
- The diagnostic categories mostly associated with pneumothorax: respiratory diseases with sepsis and septic shock coming next.
- Most cases of pneumothorax were iatrogenic in etiology caused by barotrauma related to mechanical ventilation with CVC insertion coming next in etiology of pneumothorax.

- A high incidence of mechanical ventilation among cases of pneumothorax which explains relative high incidence of tension pneumothorax
- Pneumothorax in mechanically ventilated patients is related to underlying lung disease along with high ventilatory settings.
- Pneumothorax was primarily diagnosed with plain radiography.

Our recommendations:

- Close monitoring of all PICU patients especially ventilated cases for detection of early signs of pneumothorax
- Strict application of protective lung strategies in order to minimize occurrence of pneumothorax in mechanically ventilated cases.
- Further use of ultrasonography in diagnosis of pneumothorax due to its high sensitivity and specificity.
- Use of ultrasonography guidance during insertion of central lines to minimize pneumothorax and other complications secondary to CVC insertion.

SUMMARY

Pneumothorax in critically ill patients remains a common problem in the ICU, which represents a potentially life threatening event, particularly if associated with mechanical ventilation.

Pneumothorax can be spontaneous or iatrogenic, with iatrogenic pneumothorax being more common worldwide.

Pneumothorax should be considered a medical emergency and requires a high index of suspicion, prompt recognition and intervention. The diagnosis of pneumothorax in critically ill patients can be made by physical examination findings, or radiological studies including chest x- ray and CT scan.

The aim of this work is to evaluate cases with pneumothorax among admissions to pediatric intensive care unit over 5 years period.

This study was conducted on all patients admitted to pediatric intensive care unit between 1st of January 2008 to 31st of December 2012 (n=1298 cases). All the files were reviewed showing 135 cases developed pneumothorax which was compared with the rest of the cases who did not develop pneumothorax in order to study the incidence, hazards and complications of pneumothorax in PICU.

The files of all patients were reviewed for history, physical examination, diagnosis, mortality probability on admission performed using PIM2 score, degree of organ dysfunction using PELOD score on admission and on daily basis, need for mechanical ventilation , ventilator settings and fate (discharged or deceased). Files of patients with pneumothorax were reviewed for etiology of pneumothorax, severity, primary tool for diagnosis, management and complications.

The results revealed statistically significant higher mortality, longer length of stay, younger age, lower body weight, higher PIM2 score and higher PELOD score in cases with pneumothorax.

The study showed that iatrogenic pneumothorax is more common than spontaneous pneumothorax. The most common cause of pneumothorax in the study was barotrauma related to mechanical ventilation followed by CVC insertion. The most common tool for diagnosis used was chest x-ray followed by clinical suspicion with no rule of bedside ultrasonography in this study.

The results also showed that in mechanically ventilated cases there was statistically significant longer duration of ventilation and higher ventilator settings in both CMV (higher PEEP, PIP, rate and FiO_2) and HFVO (higher mean airway pressure, delta P and FiO_2) in cases with pneumothorax.

The results clarified significant lower P_aO_2 and higher P_aCO_2 in patients with pneumothorax compared to those without with no significant difference as regards CRP, WBC count and S_aO_2.

On comparing ABG parameters on admission and on occurrence of pneumothorax, the results showed statistically significant lower pH, P_aO_2, S_aO_2 and higher P_aCO_2 on occurrence of pneumothorax.

Since most common cause of pneumothorax in our study is barotrauma related to mechanical ventilation so it is very important to strictly apply protective lung strategies in order to minimize risk of pneumothorax.

CONCLUSION

- Pneumothorax is a potentially life threatening complications occurring in PICU and is associated with prolonged length of stay, increased morbidity and mortality.
- The diagnostic categories mostly associated with pneumothorax: respiratory diseases with sepsis and septic shock coming next.
- Iatrogenic pneumothorax is more common than spontaneous pneumothorax. In our study, the most common cause of pneumothorax is barotrauma related to mechanical ventilation with CVC insertion coming next in aetiology of pneumothorax.
- A high incidence of mechanical ventilation among cases of pneumothorax which explains relative high incidence of tension pneumothorax
- Pneumothorax in mechanically ventilated patients is related to underlying lung disease along with high ventilatory settings and longer duration of mechanical ventilation.
- On development of pneumothorax, most cases showed respiratory acidosis, hypercapnia and hypoxemia.
- Pneumothorax was primarily diagnosed with plain radiography, with no role of bedside ultrasonography.
- Most cases were managed with chest tube insertion.