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# Management and Outcome of Methicillin Resistant *Staphylococcus aureus* related Pneumatoceles in Extremely Low Birth Weight Infants

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## Abstract

The author describe 3 case reports on pneumatoceles in extremely low birth weight infants. Pneumatoceles are rare complication of pneumonia caused by *Staphylococcus aureus*. After the introduction of noninvasive ventilatory strategies in ELBW infants, the number of cases of ventilator associated pneumonia and its complications came down. Early identification and prompt treatment can reduce the complications associated with the pneumatocele. Management of underlying condition and gentle ventilation cures most of the cases. Surgical intervention is rarely required with new modes of ventilation.

***Keywords:*** *Pneumatocele; Staphylococcus aureus; ELBW Infants*

## Introduction

Cystic lung diseases are relatively rare conditions but can contribute to significant morbidity and mortality. The two common acquired cystic diseases are pulmonary interstitial emphysema (PIE) and pneumatocele. Both conditions are rare after the era of surfactant and recent trend in practice of lung protective ventilation. Pneumatoceles are thin walled cystic lesions with in the lung parenchyma resulting from bronchial injury and inflammation that increases in size over a period of days or weeks but eventually decreases in size with the treatment of underlying condition [1-3]. The wall of the cyst is thin walled in contrast to the abscess in which case it is thick walled and irregular. Even though the pneumatocele associated with RDS has fallen down over the years we still see pneumatocele resulting from infections. In older infants and children aspiration and trauma can also cause pneumatocele. Pneumatoceles are very often radiological diagnosis and clinical features are not different from underlying conditions unless complications develop. The mainstay of treatment is management of the underlying condition and avoidance of excessive pressure from the ventilator. Most of the cases disappear over time even though it might take months to recover.

## Case 1

A baby girl AS, of birth weight 738 gram was born by caesarian section at 27 weeks of gestation. The antenatal history of her 29 year old mother was complicated by premature rupture of membrane of membrane of 12 days duration and oligohydramnios. The prenatal screens were negative except for the GBS which was unknown. Mother received antibiotics and betamethasone. She was born depressed required intubation from delivery room. The Apgar scores were 1 and 7 at 1' and 5' respectively. Infant's course in NICU was complicated by severe RDS requiring 3 doses of beractant (Survanta, Ross Laboratories, Columbus, OH, USA) and ventilated initially for 21 days. 2 days after extubation she developed Methicillin Resistant *Staphylococcus* blood stream infection and reintubated. 2 weeks later she had increased ventilator requirements even though the blood culture was sterile by that time. The sputum culture showed MRSA and the CXR showed right sided pneumatocele.

The vancomycin and gentamicin continued and Rifampicin was started. After seeing the pneumatocele the mean airway pressure decreased and the subsequently extubated to nasal intermittent positive pressure ventilation (NIMV) after 10 days. After 11 days of NIMV she was put on nasal cannula. The pneumatocele disappeared after 2 weeks. She subsequently developed bronchopulmonary dysplasia requiring diuretics and discharged on 1/2L 100% O2 after 102 days of hospital discharge.

## Case 2

A baby boy BS, of birth weight 955 gram was born by spontaneous vaginal delivery at 26 weeks of gestation. The antenatal history of his 31 year old mother was complicated by fibroid uterus and preterm labor. The prenatal screens were negative except for the GBS which was unknown. Mother received antibiotics and betamethasone and the rupture of membrane was at delivery. He developed respiratory distress soon after birth and was intubated from delivery room. The Apgar scores were 8 and 9 at 1' and 5' respectively. Infant's course in NICU was complicated by severe RDS requiring 3 doses of beractant (Survanta, Ross Laboratories, Columbus, OH, USA) and ventilated initially for 41 days. He received indomethacin on D6 of life for hemodynamically significant PDA. On D20 of life she became sick and the blood culture showed methicillin resistant *Staphylococcus aureus* (MRSA) and the sputum culture was also positive for MRSA. The repeat sputum culture after 2 days showed MRSA and *E. coli*. He was treated with vancomycin and gentamicin. Vancomycin continued for 6 weeks. The blood was cleared of organism after 7 days and the sputum after 9 days. The mechanical ventilation was continued with lower mean airway pressure and extubated on 41$^{st}$ day of life. But he developed BPD and pulmonary hypertension requiring re intubation, hood oxygen and then nasal cannula. He received inhaled bronchodilator therapy, diuretics and steroids for BPD. Meanwhile the size of pneumatocele increased and the CT chest showed shift of mediastinum to opposite side. So the decision was made to operate and right lower lobectomy was done on D61 of life. Baby was the discharged from the NICU after 7 months of hospital stay on ¼ L 100% Oxygen.

## Case 3

A baby boy CS, of birth weight 590 gram was born by spontaneous vaginal delivery at 25 weeks of gestation. The antenatal history of his 24 year old mother was complicated by incompetent cervix, abruption placenta and preterm labor. The prenatal screens were negative except for the GBS which was unknown. Mother received antibiotics and betamethasone and the rupture of membrane was at delivery. He was born severely depressed requiring intubation, chest compression and fluid resuscitation from delivery room. The Apgar scores were 4, 3 and 4 at 1', 5' and 10' respectively. Infant's course in NICU was complicated by severe RDS requiring 3 doses of beractant (Survanta, Ross Laboratories, Columbus, OH, USA) and ventilated initially for 39 days. He was undergone PDA ligation for hemodynamically significant PDA on D7 of life. He developed pulmonary interstitial emphysema on D3 of life which was resolved after 5 days. On D23 of life, while on minimal ventilator settings he developed MRSA pneumonia and sepsis and required higher ventilator support. The sputum and the blood culture showed MRSA. The blood was cleared quickly and sputum required 2 weeks to clear of the organism. 2 days after he developed pneumonia, the CXR showed pneumatocele (Figure 1), initially on right side and then left side. The pneumatocele size gradually increased and then after 1wwek it was stabilized. He was initially treated with lower mean airway pressure and then shifted to high frequency oscillatory ventilator. After 3 weeks of HFOV he was extubated to nasal IMV which was continued for 20 days and the put on nasal cannula. The pneumatocele disappeared after 3 ½ months. He developed BPD requiring diuretics and was discharged after 144 days of hospital stay.

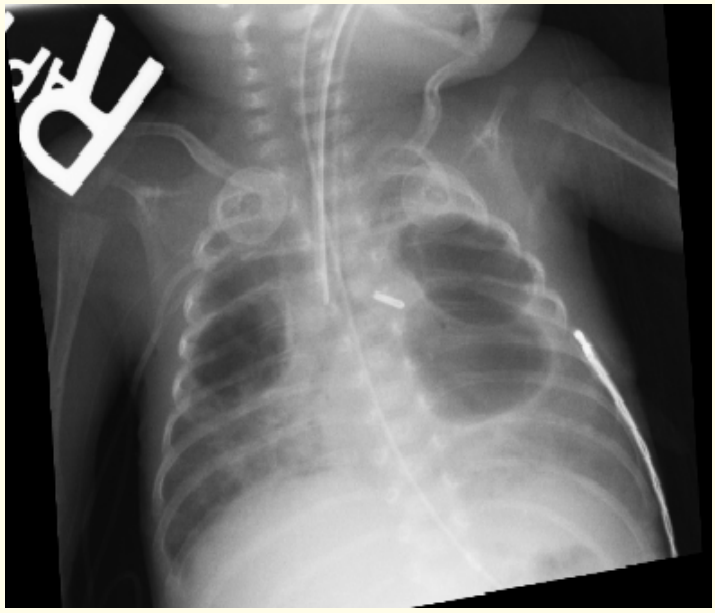

***Figure 1:*** *Chest X Ray showing multiple pneumatocele. 2 on left side and 1 on right side.*

## Discussion

Here we report three cases of pneumatocele managed differently. All the three cases were caused by MRSA pneumonia. The antibiotics were given for at least 3 weeks in all cases. The first case was managed by lowering the mean airway pressure and pneumatocele disappeared after 2 weeks. The second case was complicated by severe BPD and pulmonary hypertension and required pneumonectomy. The third case was managed by lowering the mean airway pressure, HFOV and NIMV and subsequently resolved by over time. There is no uniformly accepted algorithm for the management of pneumatocele.

In neonates the causes includes ventilator induced lung injury, pneumonia due to *Staphylococcus*, *Streptococcus pneumoniae*, *Haemophilus influenzae* type B, *Klebsiella pneumoniae, Enterobacter cloacae*, *Serratia marcescens*, *Pseudomonas aeruginosa* and *Escherichia coli* [1,2]. Aspiration pneumonia has been reported to cause pneumatocele in neonates taking oral feeds. Improper suction can also cause pneumatocele by causing injury to the lung. There is no specific genetic factor known to predispose to the development of pneumatocele. Pneumatoceles are associated with hyperimmunoglobulin E syndrome because of recurrent staphylococcal infections [2]. The exact mechanism of pneumatocele formation is not known. The proposed mechanism involves the formation of check valve type of airway obstruction with resultant airway trapping and cyst formation. The check valve allows one way passage of air causing distension. The initiating events include epithelial injury from airway collapse and re-opening (RDS, pneumonia), volutrauma and or barotrauma from mechanical ventilation, the cytokines and inflammatory mediators causing exudation and airway narrowing [1].

Even though the pneumatocele can affect both lobes of the lung the most common site of involvement is on right middle and lower lobes. A single institution retrospective study of infants < 30 weeks gestational age have shown that the incidence of pneumatocele was found to be 1.8% with male preponderance [1]. Pneumatoceles are seen in 2 - 8% children hospitalized for pneumonia [2]. The incidence was found to be less after the discovery of surfactant. The majority of pneumatoceles were associated with pulmonary interstitial

emphysema before the era of surfactant. The complications include pneumomediastinum, pneumothorax and compression of the adjacent lung causing respiratory failure. The rapid enlargement of pneumatocele resulting in compression of adjacent lung and respiratory failure is called tension pneumatocele. Secondary infection of the pneumatocele with the development of air fluid level and sepsis has been reported [1,2]. The pneumatocele should be distinguished from other cystic conditions of the lung including CPAM, pulmonary sequestration, PIE, bronchogenic cyst, congenital lobar emphysema and Wilson–Mikity syndrome [3].

Treatment depends on the underlying cause of the pneumatocele. Most cases of pneumatocele resulting from RDS or pneumonia resolve either by decreasing the mean airway pressure or by extubation. Some of the cases respond to high frequency ventilation or by selective ventilation of the contralateral lung. In order to avoid the collapse of contralateral lung in case of selective intubation, a tube with a side hole can be used [4]. The high frequency oscillatory ventilation helps by decreasing mean airway pressure, decreasing barotrauma and improving the gas exchange. Complicated cases require other modalities of treatments including image guided percutaneous catheter aspiration. This can be done using 6 Fr pigtail catheter under fluoroscopic guidance. The complications include bronchopleural fistula [3]. Video-assisted thoracoscopic surgery (VATS) has been successfully used for the treatment of pneumatocele. The advantage of VATS includes direct visualization of the lung tissues without exposing to high radiation for long time [5]. The duration of antibiotics in case of infection associated pneumatocele is controversial. Antibiotics continued for at least 3 weeks in most of the case reports [2]. The surgical resection is indicated in those who fail the treatment options mentioned above and also in selected cases associated with congenital heart disease. The mortality associated with pneumatocele in a retrospective study by Husaain., *et al*. was 26%. The death is usually due to the underlying cause rather that the pneumatocele itself. In the same study they did not find any long term complication. But it is difficult to conclude whether the long term pulmonary complications are associated with pneumatocele itself or due to chronic lung disease associated with prematurity [1].

## Conflict of Interest

No financial relationship relevant to this article to disclose.

## Disclaimer

The views expressed in the submitted article are author's own and not an official position of the institution.

## Consent

Informed consent was obtained from the parents.

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