Culture and sensitivity patterns of the causative organisms isolated from the patient of Empyema Thoracis

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SK MY MM conceived idea, SK MY ST FJ drafted the study, MY FJ MA collected data, MY ST MM did statistical analysis and interpretation of data, SK MY FJ ST critical review manuscript, All approved final version to be published.

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The authors declare that there is no conflict of interest.

Abstract

Background: Empyema thoracis, defined as collection of pus in the pleural space has been recognized since centuries ago and historically has been associated with high mortality. The mortality rate from empyema thoracis remains high despite enormous advancement in the use of good antibiotics. Objective of the present study was to determine the frequency of different patterns of culture and sensitivity of organisms causing empyema thoracis.

Methodology: This was a descriptive cross-sectional study. By non-probability consecutive sampling all empyema thoracis patients of age 20 to 60 years admitted in Pulmonology unit of Ayub Teaching Hospital Abbottabad, Pakistan were studied. The study was conducted from May 2018 to March 2019.The diagnosis of empyema thoracis was established by analysis of the pleural fluid aspirated from the pleural space via needle attached to a syringe. Data was intered on a specifically designed proforma and was analyze by SPSS 25.

Results: Male patients were 148 (67.6%) and the remaining 71 were females. Culture was positive in 72 (32.9%) patients. The most commonly isolated organisms were Bacteroides comprising 6.8% of total study population while other isolates were Streptococcus pneumoniae (4.1%), Staphylococcus aureus (6.4%), E-coli(3.7%), Klebseilla pneumoniae (2.7%), Peptococcus (3.2%), Streptococcus milleri (1.8%) and polymicrobial infection (4.1%). Sensitivity to ciprofloxacin, moxifloxacin, cefotaxime and ceftriaxone was highest (28.3% each) while it was 26.0% to each cephradine and Co-amoxiclav, 21.9% to amoxicillin and 27.4% to gentamycin.

Conclusion: Empyema fluid culture is positive in less than one third of empyema thoracis patients and majority of the involved organisms are sensitive to most of the commonly prescribed antibiotics.

Key words: Empyema; Pneumonia; Culture and Sensitivity; Antibiotics

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Introduction

Empyema thoracis is defined as pus in the chest.[1,2] It is also called pyothorax or purulent pleuritis. It is an old disease being well known from centuries ago.[3] The most common cause has been bacterial pneumonia with subsequent parapneumonic effusion. Other important causes include bronchiectasis, lung abscess, chest trauma, some spread from abdominal organs and post surgical causes. Spontaneous bacterial empyema is rare.

Empyema thoracis is considered an important medical illness since long times and has been always caused significant morbidity and mortality globally. In United States approximately one million patients with pneumonia get hospitalized each year. A lot of patients among those get complications in the form of parapneumonic effusion and too many even progress to empyema.[2] Around one third of those patients require major surgical interventions and 15% die.[3,4] Before the advent of antibiotics progression to empyemas was quite often in cases of pneumonias but antibiotics usage has caused an enormous improvement in this regard. It is however being observed with the passage of time that the incidence of empyema is again on the rise.[5] Important risk factors for development of empyema include pneumonia requiring hospitalization and other comorbid conditions like bronchiectasis, chronic obstructive pulmonary disease (COPD), alcoholism, epilepsy, diabetes, immune deficiency and surgery or recent trauma.

Various organisms have been isolated from cultures of empyema fluid in different patients. Most important among these include gram negative bacteria, streptococcus pyogenes, streptococcus milleri, bacteroides, peptostreptococcus and staphylococcus aureus.[6-11]

Antibiotics sensitivity of empyema fluid specimens have demonstrated a considerable amount of resistance to commonly used antibiotics.[12] Various studies have been done on empyema thoracis in an effort to isolate the single most common agent, but the results are variable among different studies and in different setups describing different pathogens in various frequencies. There is no consensus about a single pathogen and single antibiotic coverage for empyema thoracis.[12] This highlights the need for studies to be done in individual setups in order to detect single most common regimen and to administer empirical therapy based on culture and sensitivity patterns.

Hence current study was conducted to estimate the frequency of bacterial isolates and their antibiotic sensitivity of patients with empyema thoracis as prime objective. This study helped in determining the most common microorganisms and the culture and sensitivity patterns among those patients. These findings will be of great help in early recognition of the cause of empyema and as a result initiation of definitive therapy will help in reducing morbidity and mortality associated with empyema thoracis.

Methodology

This hospital based descriptive cross-sectional study was conducted at Pulmonology Unit of Ayub Teaching Hospital Abbottabad, Pakistan from May 2018 to March 2019. After obtaining permission from the ethics committee of the hospital written informed consents were obtained from each study participant. Patients of both gender i.e. male and female between age 20 to 60 years were included in the study. Patients with malignant chest disease, those who took antibiotics for more than two weeks prior to presentation and post traumatic and post-surgical empyema patients were excluded from the study. A total of 219 cases fulfilling inclusion criteria were registered. Diagnosis of empyema thoracis was established by analysis of pleural fluid aspirated from the pleural space via conventional needle attached to a syringe. Demographic history was recorded. All the patients underwent pleural drainage procedure in the form of tube tharacostomy with initiation of empiric antibiotics for pleural infection. Five milliliter pus specimens were collected in sterilized disposable syringes for culture and sensitivity testing. Antibiotics were later on switched over according to culture and sensitivity report. The following antibiotics were included for sensitivity testing: Cephradine, Cefotaxime, Ceftriaxone, Ciprofloxacin, Co-amoxiclav, Amoxicillin, Gentamicin, Amikacin and Moxifloxacin. These were labeled as sensitive or resistant on the basis of results. All the information was collected on a specially designed proforma. Confounders and bias were controlled by strictly following inclusion and exclusion criteria.

Data was entered into SPSS version 25 and analyzed. Categorical variables like demographics, gender, type of cultured microorganisms and antibiotics sensitivity were described as frequencies and percentages. Quantitative variables like age were described as mean and standard deviation. Culture and sensitivity of different drugs were stratified by gender and age. Chi square test was used to evaluate differences in culture and sensitivity between different age and gender groups.

Results

Mean age of the patients was 41.73 ± 12.95 years ranging from 20 to 60 years. Out of total 219 patients, 148 (67.6%) were males while 71 (32.4%) were females. Seventy two (32.9%) patients turned out to be culture positive while the remaining 147 (67.1%) patients were culture negative. Out of culture positive patients 46 were males while 26 were females. Out of all 219 patients 4 (1.8%) had positive culture growth of poly microbial infections, 9 (4.1%) had Streptococcus pneumoniae, 14 (6.4%) had Staphylococcus aureus, 8 (3.7%) had E-coli, 4 (1.8%) had Streptococcus milleri, 15(6.8%) had Bacteroides, 6 (2.7%) had Klebseilla

Table 1. Percentages of cultured microorganisms with gender wise stratification

Microorganisms cultured	Status	Male		Female		Total	
Poly microbial	Yes	2	0.90%	2	0.90%	4	1.80%
	No	42	19.20%	21	9.60%	63	28.80%
	Not applicable (i.e; other than poly microbial)	104	47.50%	48	21.90%	152	69.40%
	Total	148	67.60%	71	32.40%	219	100.00%
Streptococcus pneumoniae	Yes	4	1.80%	5	2.30%	9	4.10%
	No	40	18.30%	18	8.20%	58	26.50%
	Not applicable (i.e; other *Streptococcus pneumoniae)*	104	47.50%	48	21.90%	152	69.40%
	Total	148	67.60%	71	32.40%	219	100.00%
Staphyococcus aureus	Yes	9	4.10%	5	2.30%	14	6.40%
	No	35	16.00%	18	8.20%	53	24.20%
	Not applicable (i.e; other than Staphyococcus aureus)	104	47.50%	48	21.90%	152	69.40%
	Total	148	67.60%	71	32.40%	219	100.00%
E.coli	Yes	5	2.30%	3	1.40%	8	3.70%
	No	39	17.80%	20	9.10%	59	26.90%
	Not applicable (i.e; other than ***E.coli)***	104	47.50%	48	21.90%	152	69.40%
	Total	148	67.60%	71	32.40%	219	100.00%
Streptococcus milleri	Yes	3	1.40%	1	0.50%	4	1.80%
	No	41	18.70%	22	10.00%	63	28.80%
	Not applicable (i.e; other than***Streptococcus milleri)***	104	47.50%	48	21.90%	152	69.40%
	Total	148	67.60%	71	32.40%	219	100.00%
Bacteroides	Yes	11	5.00%	4	1.80%	15	6.80%
	No	33	15.10%	19	8.70%	52	23.70%
	Not applicable (i.e; other than Bacteroides)	104	47.50%	48	21.90%	152	69.40%
	Total	148	67.60%	71	32.40%	219	100.00%
Klebsiella pneumoniae	Yes	2	0.90%	4	1.80%	6	2.70%
	No	42	19.20%	19	8.70%	61	27.90%
	Not applicable (i.e; other than Klebsiella pneumoniae)	104	47.50%	48	21.90%	152	69.40%
	Total	148	67.60%	71	32.40%	219	100.00%
Peptococcus	Yes	5	2.30%	2	0.90%	7	3.20%
	No	39	17.80%	21	9.60%	60	27.40%
	Not applicable (i.e; other than Peptococcus)	104	47.50%	48	21.90%	152	69.40%
	Total	148	67.60%	71	32.40%	219	100.00%

Others (Pseudomonas, Proteus)	Yes	5	2.30%	0	0%	5	2.30%
	No	39	17.80%	23	10.50%	62	28.30%
	Not applicable (i.e; other than Pseudomonas, Proteus)	104	47.50%	48	21.90%	152	69.40%
	Total	148	67.60%	71	32.40%	219	100.00%

Table 2. Overall Percentages of Sensitivity of antibiotics and its gender wise stratification

Antibiotics C/S	Status	Male		Female		Total	
Cephradine	Yes	36	16.40%	21	9.60%	57	26.00%
	No	8	3.70%	2	0.90%	10	4.60%
	Not applicable	104	47.50%	48	21.90%	152	69.40%
	Total	148	67.60%	71	32.40%	219	100.00%
Cefotaxime	Yes	42	19.20%	20	9.10%	62	28.30%
	No	2	0.90%	3	1.40%	5	2.30%
	Not applicable	104	47.50%	48	21.90%	152	69.40%
	Total	148	67.60%	71	32.40%	219	100.00%
Ceftrioxone	Yes	41	18.70%	21	9.60%	62	28.30%
	No	3	1.40%	2	0.90%	5	2.30%
	Not applicable	104	47.50%	48	21.90%	152	69.40%
	Total	148	67.60%	71	32.40%	219	100.00%
Ciprofloxacin	Yes	40	18.30%	22	10.00%	62	28.30%
	No	4	1.80%	1	0.50%	5	2.30%
	Not applicable	104	47.50%	48	21.90%	152	69.40%
	Total	148	67.60%	71	32.40%	219	100.00%
Co amoxiclav	Yes	39	17.80%	18	8.20%	57	26.00%
	No	5	2.30%	5	2.30%	10	4.60%
	Not applicable	104	47.50%	48	21.90%	152	69.40%
	Total	148	67.60%	71	32.40%	219	100.00%
Amoxicillin	Yes	32	14.60%	16	7.30%	48	21.90%
	No	12	5.50%	7	3.20%	19	8.70%
	Not applicable	104	47.50%	48	21.90%	152	69.40%
	Total	148	67.60%	71	32.40%	219	100.00%
Gentamicin	Yes	42	19.20%	18	8.20%	60	27.40%
	No	2	0.90%	5	2.30%	7	3.20%
	Not applicable	104	47.50%	48	21.90%	152	69.40%
	Total	148	67.60%	71	32.40%	219	100.00%

Moxifloxacin	Yes	42	19.20%	20	9.10%	62	28.30%
	No	2	0.90%	3	1.40%	5	2.30%
	Not applicable	104	47.50%	48	21.90%	152	69.40%
	Total	148	67.60%	71	32.40%	219	100.00%

pneumonae, 7 (3.2%) had Peptococcus and 5 (2.3%) had others (Pseudomonas and Proteus) as noted in table 1.

With regard to sensitivity, out of total of 219 individuals 62 (28.3%) demonstrated sensitivity to each of cefotaxime, ceftriaxone, ciprofloxacin and moxifloxacin, 60 (27.4%) to gentamycin, 57 (26.0%) to each of cephradine and Co-amoxiclav and 48 (21.9%) to amoxicillin (Table 2).

Discussion

To our knowledge this was the first regional study that investigated the spectrum of microorganism and antibiotic sensitivity pattern in the patients with empyema thoracis. In this study bacterial culture yielded positive results in only 32.9% patients. Our study comprised of predominantly male population (i.e. 67.6%). The most commonly cultured organisms were bacteroides (i.e. 6.8%) while staphylococcus aureus was the second most common organism (i.e. 6.4%) among the list. The highest level of sensitivity was noted for cefotaxime, ceftriaxone, ciprofloxacin and moxiflixacin (28.30% each).

Various studies have demonstrated isolation of different organisms from cultures of empyema fluid in different patients. Studies conducted in our country, India and Canada revealed male predominance (68.2%, 75.4%, 64% respectively). Our findings are consistent with those studies.[13-15] The probable reason for this male predominance may be the X-linked genes responsible for immunoglobulin production hence rendering males population more vulnerable to such type of infections.[16,17] Some Pakistani studies reported positive culture in 52.7% of patients, with the Pseudomonas as the most common isolate (18.8%) and better sensitivity for amoxicillin/clavulanic acid, ertapenem, clarithromycin, colistin, vancomycin, fosfomycin, and tigecycline against bacterial organisms.[13] In a study by Tareen et al, it was reported that gram negative enteric rods (91%) were the most common agents followed by Streptococcus pyogenes (5.4%) being the only other organism isolated.[18] These findings are in contrast to our study. The possible reason may be the difference in study population. A worrisome point in these findings is high level of antibiotic resistance to antibiotics noted in our study and other similar studies.[19-23] Antibiotics resistance is a considerable problem globally and particularly in developing countries. The most probable reason for this problem seems irrational use of antibiotics.[24-27]

The literature recommends early diagnosis and treatment of empyema in order to avoid the terrible complications associated with this disease.[27] Early initiation of treatment can also reduce the economic burden and sufferings. However early treatment is not possible in so many cases and a lot majority of patients do develop chronic empyema. At the advanced stage open thoracotomy or video-assisted thoracoscopic surgery (VATS) with decortication becomes necessary interventions.[28]

Bcateriae are cultured on samples from pleural fluid. Interestingly, an important marker lactate dehydrogenase is consistently elevated in empyema fluid.[29] Imaging studies for the diagnosis and evaluation consist of X-Ray, ultrasound and CT scan. Ultrasound is the investigation of choice for detecting loculations while CT scan can demonstrate pleural anatomy, septations and quantity of the empyema fluid.[29]

In order to reduce the development of empyema attempts to identify the possible risks are mandatory. Most common risk factors include old age, severe pneumonias, immunocompromised state, bronchiectasis, some neurological diseases, diabetes mellitus and chronic obstructive pulmonary disease.[30,31] It is recommended to manage the associated comorbidities in an optimal way as the success of treatment depends considerably on better management of the associated comorbidities.[31]

Study Limitations

Our study had several limitations. Firstly, we did not analyze culture for mycobacterium tuberculosis and some atypical bacteriae because it was costly and time consuming. Secondly, many patients with empyema were already taking antibiotics before samples for their culture were submitted. Thirdly, we were not able to do antibiotic sensitivity testing for some newer antibiotics. Fourthly, we studied a small group of patients so our results may not be considered as a true representative of a large population.

Conclusion

Culture is positive in a considerable number of patients with empyema thoracis therefore culture and sensitivity should be performed in all empyema thoracis patients. This along with knowledge of bacterial sensitivity may help us manage the patients accordingly in a better way thereby reducing morbidity and mortality associated with empyema thoracis.

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