Original Article

Frequency of Bacterial Microorganisms in Exudative Pleural Effusion

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ABSTRACT

OBJECTIVE: To determine the bacterial etiology of exudative pleural effusion.

METHODOLOGY: A cross-sectional study on newly diagnosed patients of Exudative Pleural Effusion was conducted at medicine department of Dow University Hospital, Karachi from August 2019 to January 2020. Out of 177 patients of age 18-75 years were enrolled by consecutive non-probability sampling technique. Patients of Tuberculosis, heart failure, chronic liver disease, chronic renal failure or patients on diuretic therapy were excluded. Pleural fluid was detected via chest x-ray followed by diagnostic thoracentesis for bacterial confirmation.

RESULTS: Out of 177 Exudative Pleural Effusion patients, male patients were 106 (59.9%) and female patients were 71 (40.1%). Bacterial microorganisms were detected in 67 (37.9%) patients, among which most common were Staphylococcus Aureus 13 (19.4%) and Escherichia Coli 13 (19.4%) followed by Acetobacter Baumannii 12 (17.9%), Streptococcus pneumonia 9 (13.4%), Staphylococcus Epidermidis 6(9.0%), Pseudomonas Aeruginosa 5 (7.5%), Enterococcus Spp 5 (7.5%) and Enterobacter Aerogenes 4 (6.0%).

CONCLUSION: Frequency of bacterial microorganisms in Exudative Pleural Effusion was high among adult patients. Escherichia Coli, Staphylococcus Aureus and Acetobacter Baumannii were commonly detected pathogens from Exudative Pleural Effusion.

KEYWORDS: Pleural Effusion, Diagnostic, Morbidity, Mortality, Therapeutic.

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INTRODUCTION

Pleural Effusion (PE) is the most common disease among all the pleural diseases, in which anomalous collection of fluid occurs either in pleural space or in pleural cavity[1,2]. It is a clinical problem in which rate of production of pleural fluid is exceeded than absorption limit of pleural fluid in pleural space. Rate of morbidity and mortality is higher in patients experiencing Pleural Effusion[3]. Globally Pleural Effusion affecting more than 1.3 million people per year[4].

Pleural fluid is an Ultra-Filtrate of plasma, classified as Transudate or Exudate. Transudate Pleural Fluid is derived from across a membrane with low protein content whereas Exudate Pleural Fluid is derived either from active secretion or leakage with high protein content[5]. Exudative Pleural Effusion (EPE) occurred because of raised Capillary Permeability or Impaired Lymphatic Drainage which results from the Proliferative (such as due to malignancy) or inflammatory (such as due to Parapneumonic Effusions) processes[6]. EPE is caused by Tuberculosis, Malignancy, Rheumatoid Pleurisy, Fungal Pleurisy, Sarcoidosis, Parasitic diseases (such as Echinococcus Granulossis), Bacterial Pneumonia, lung abscess, and bronchiectasis[7,8]. Infective exudative pleural effusion results mostly due to tuberculosis (tuberculous pleural effusion) and bacterial pneumonia (Parapneumonic Effusions). Causative microorganisms of infective pleural effusion include; Pneumococcus Pneumoniae, Staphylococcus aureus, Klebsiella pneumoniae, Escherichia coli, Streptococcus milleri group, Mycoplasma pneumoniae and anaerobic bacteria such as bacteroides. Nocardia, Actinomyses species, fungi and parasitic infections, such as Paragonimus Miyazaki, Paragonimus westermani and Echinococcus are also responsible for exudative pleural effusion[9,10].

Different studies have been conducted throughout the world on infective microorganisms in pleural effusions. Such as a study by Abdollahi A, et al.[11] reports the lower frequency of patients (11.7%) with positive cultures in pleural fluid. Among which 52% were gram negative (Acinetobacter baumannii 16.4%, Pseudomonas aeruginosa 4.8%), 25.3% were gram positive (Staphylococcus aureus 19.2%, Streptococcus pneumonia 8.2%, Staphylococcus epidermidis 6.8%), 15.7% anaerobic gram negative (Escherichia coli 13.7%, Enterobacter aerogenes 2.0%) and 6.2% anaerobic gram positive (Enterococcus species 5.5%). Another study by Porcel J, et al[12]. reports the 41% patients with positive cultures in pleural fluid. Among which 67% microorganism were gram positive (Viridans

streptococci 20.4%, Streptococcus pneumoniae 18.3%, Staphylococcus aureus 12.9% and Enterococcus faecalis 7.5%), 24% gram negative (Escherichia coli 7.5%, Pseudomonas aeruginosa 4.3%, Proteus mirabilis 3.2% and Salmonella enteritidis 2.1%) and 6% anaerobic bacteria (Clostridium specie 2.1%).

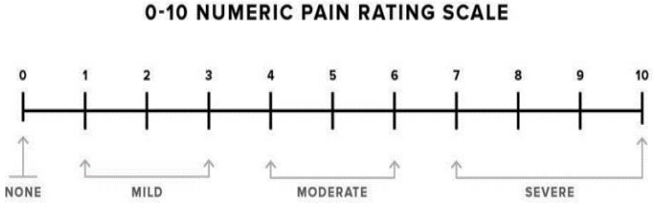
The study objective is determination of bacterial microorganism in newly diagnosed patients of exudative pleural effusion. It is very much common due to infective accumulation of fluid in pleural space and because of administration of antibiotics the micro-organisms responsible of pleural effusion has changed accordingly. Local data is also scarce regarding this study in population of Sindh and International data is not applicable on our population due to variation in demographic and geographical characteristics. Therefore, this study has been designed on our population that will be helpful in determination of bacterial microorganisms responsible for exudative pleural effusion.

METHODOLOGY

A cross-sectional study on newly diagnosed patients of Exudative Pleural Effusion was conducted at medicine department of Dow University Hospital, Karachi from August 2019 to January 2020.

All newly diagnosed patients of Exudative Pleural effusion with age of 18-75 years were enrolled in study by consecutive sampling technique whereas patients of tuberculosis, heart failure, chronic liver disease, chronic renal failure or patients on diuretic therapy were excluded. Open EPI software was used for sample size calculation with reported prevalence of 6% anaerobic gram-positive bacteria in diagnosed patients of pleural fluid[11], along with 95% confidence interval (CI) and 3.5% margin of error (MOE). Calculated sample size was 177. Presence of unusual and excessive amount of pleural fluid in pleural space or cavity with or without symptoms was labelled as pleural effusion. Large amount of pleural fluid > 500 ml was diagnosed with clinical symptoms whereas small amount of pleural fluid < 500 ml was diagnosed without clinical symptoms. Commonly reported symptoms of pleural effusion were; chest pain i.e., sharp, localized and were confirmed via numeric rating scale (NRS), dyspnea, pleurisy, dry or productive cough, fever (> 100.4 °F persistent for ≥ 48 hours) and chills.

FIGURE I: NUMERIC PAIN RATING SCALE



Exudative pleural effusion was diagnosed on the basis of light's criteria[13];

TABLE I: LIGHT'S CRITERIA

An exudative pleural effusion meets ≥ 1 of the following criteria;	
1	Pleural fluid protein / serum protein > 0.5
2	Pleural fluid / serum lactate dehydrogenase (LDH) > 0.6
3	Pleural fluid LDH > 2/3 the upper normal limit for serum LDH

British Thoracic Society (BTS) Pleural Disease Guidelines guidelines was used for confirmation of microorganisms either on the basis of plural fluid gram stain and/or positive culture and/or pleural fluid pH < 7.20 and/or glucose < 3.4 mmol/L[14].

Each patient was inquired about clinical sign and symptoms of pleural effusion including chest pain, dyspnea, pleurisy, cough, fever and chills. Chest x-ray was performed for confirmation of pleural fluid. All selected patients underwent for diagnostic thoracentesis under aseptic conditions, and the pleural fluid was processed for measurement of pH, glucose, protein, lactate dehydrogenase, cell count and bacterial cultures. Blood sample of each patient was collected in aseptic conditions and sent to laboratory for serum protein and serum LDH. Statistical Package for Social Science (SPSS) software, Version 25 was used for data analysis.

RESULTS

Out of 177 exudative pleural effusion patients, majority of them were male 106 (59.9%) and remaining 71 (40.1%) were female (Table III). Most of the patients were in age group of 31-45 years with 78 (44.1%) patients followed by 46-60 years with 36 (20.3%) patients, 18-30 years with 33 (18.6%) patients and 61-75 years with 30 (16.9%) patients, with mean age of 43.38±14.29 (18-75) years (Table II).

All selected patients were evaluated for different clinical parameters and were presented in mean and standard deviation including fever 100.2±1.23 (99.3-103.9) °F, chest pain score 2.73±2.70 (0-10), pH 7.7±1.6 (5.4-8.7), glucose 3.1±1.2 (2.6-3.3) mmol/L, pleural fluid protein 1.15±0.89 (0.6-2.1) g/L, serum protein 1.02±0.81 (0.6-1.9) g/L, pleural fluid LDH 188.42±16.25 (160-215) U/L and serum LDH 215.92±41.78 (140-280) U/L (Table II).

Some commonly reported clinical sign and symptoms of pleural effusion in patients were; chest pain 115 (65.0%) including mild pain 55 (31.1%), moderate pain 43 (24.3%) and severe pain
17 (9.6%), dyspnea 113 (63.8%), pleurisy 97 (54.8%), cough 78 (44.1%), fever 63 (35.6%) and chills 71 (40.1%) (Table IV).

Bacterial microorganisms were detected in 67 (37.9%) patients among which commonly reported bacterial microorganism were; Acinetobacter baumannii 12 (17.9%), Pseudomonas aeruginosa 5 (7.5%), Staphylococcus aureus 13 (19.4%), Streptococcus

pneumonia 9 (13.4%),
Staphylococcus epidermidis 6 (9.0%), Escherichia coli 13 (19.4%), Enterobacter aerogenes 4 (6.0%) and Enterococcus spp. 5 (7.5%) (Table V).
Chi-square test was applied on bacterial microorganisms and different risk factors that shows non-significant association with gender (p-value=0.4), age (p-value=0.7), chest pain(p- value=0.7), dyspnea (p-value=0.4), pleurisy (p-value=0.9), cough (p-value=0.4), fever (p- value=0.9) and chills (p-value=0.1) (Table VI).

TABLE II: DESCRIPTIVE STATISTICS OF STUDY VARIABLES (n=177)

Variable	Mean ± SD	Range
Age (Years)	43.38±14.29	18-75
Fever (°F)	100.2±1.23	99.3-103.9
Chest Pain Score	2.73±2.70	0-10
pH	7.7±1.6	5.4-8.7
Glucose (mmol/L)	3.1±1.2	2.6-3.3
Pleural Fluid Protein (g/L)	1.15±0.89	0.6-2.1
Serum Protein (g/L)	1.02±0.81	0.6-1.9
Pleural Fluid LDH (U/L)	188.42±16.25	160-215
Serum LDH (U/L)	215.92±41.78	140-280

TABLE III: FREQUENCY OF DEMOGRAPHIC VARIABLES (n=177)

Variable	Frequency	Percentage
Gender		
Male	106	59.9
Female	71	40.1
Age Groups (Years)		
18-30	33	18.6
31-45	78	44.1
46-60	36	20.3
61-75	30	16.9

TABLE IV: CLINICAL SIGN AND SYMPTOMS OF PLEURAL EFFUSION (n=177)

Variable	Frequency	Percentage
Chest Pain		
No	62	35.0
Mild	55	31.1
Moderate	43	24.3
Severe	17	9.6
Dyspnea		
Yes	113	63.8
No	64	36.2
Pleurisy		
Yes	97	54.8
No	80	45.2
Cough		
Yes	78	44.1
No	99	55.9
Fever		
Yes	63	35.6
No	114	64.4
Chills		
Yes	71	40.1
No	106	59.9

TABLE V: FREQUENCY OF MICROORGANISMS IN PLEURAL EFFUSION (n=177)

Microorganisms	Frequency	Percentage
Not Detected	110	62.1
Detected	67	37.9
Microorganisms		
Acinetobacter baumannii	12	17.9
Pseudomonas aeruginosa	5	7.5
Staphylococcus aureus	13	19.4
Streptococcus pneumonia	9	13.4
Staphylococcus epidermidis	6	9.0
Escherichia coli	13	19.4
Enterobacter aerogenes	4	6.0
Enterococcus spp.	5	7.5

TABLE VI: STRATIFICATION OF MICROORGANISM WITH RISK FACTORS (n=177)

Risk Factors	Microorganisms		P-value
	Detected (n=67)	Not Detected (n=110)	
Gender			
Male	41 (61.2%)	65 (59.1%)	0.4
Female	26 (38.8%)	45 (40.9%)	
Age Groups			

18-30	14 (20.9%)	19 (17.3%)	0.7
31-45	31 (46.3%)	47 (42.7%)	
46-60	11 (16.4%)	25 (22.7%)	
61-75	11 (16.4%)	19 (17.3%)	
Chest Pain			
No	20 (29.9%)	42 (38.2%)	0.7
Mild	23 (34.3%)	32 (29.1%)	
Moderate	17 (25.4%)	26 (23.6%)	
Severe	7 (10.4%)	10 (9.1%)	
Dyspnea			
Yes	45 (67.2%)	68 (61.8%)	0.4
No	22 (32.8%)	42 (38.2%)	
Pleurisy			
Yes	37 (55.2%)	60 (54.5%)	0.9
No	30 (44.8%)	50 (45.5%)	
Cough			
Yes	32 (47.8%)	46 (41.8%)	0.4
No	35 (52.2%)	64 (58.2%)	
Fever			
Yes	24 (35.8%)	39 (35.5%)	0.9
No	43 (64.2%)	71 (64.5%)	
Chills			
Yes	22 (32.8%)	49 (44.5%)	0.1
No	45 (67.2%)	61 (55.5%)	

DISCUSSION

Pleural effusion etiology is very important aspect in appropriate management of patients suffering from pleural effusion. The current research was performed at local population of Karachi for identification of frequency of bacteria responsible for pleural effusion and their different types affecting the local population.

In current study 177 patients of exudative pleural effusion were selected for evaluation of microorganism out of which male patients were 106 (59.9%) and female patients were 71 (40.1%) with male to female ratio of 1.5:1. A Pakistani researcher Rehan M[7] and his colleague work on pleural effusion and reported the similar pattern of male and female patients. They reported the higher male prevalence 65% and female patients were 35% with male to female ratio of 1.86:1. Another study by Abdollahi A, et al.[11] also reported the similar results, among which male patients were 61.8% and female patients were 38.2% with male to female ratio of 1.6:1. Similar study by Porcel J, et al.[12] also reported the much higher male to female ratio of 3:1. All similar studies are reporting that male patients are more affected with exudative pleural effusion as compare to female patients.

In current study approximately 60% of patients suffering from exudative pleural effusion were adults (31-60 years) followed by 18.6% in age group of 18-30 years and 16.9% elders (> 60 years) with mean age of 43.38±14.29 (18-75) years. Rehan M et al.[7] also reported the 54% of patients of exudative pleural effusion were adults (31-60 years) followed by 26% patients in 16-30 years and 20% elders (> 60 years) with mean age of 44.82±17.71 (15-60) years. Porcel J et al.[12] reported the 61.0% patients of age 40-60 years with exudative pleural effusion and 39.0% elders (> 60 years) with mean age of 61 (40-74) years. Similar to other researches, most affected age group with exudative pleural effusion was adults, also reported in literature for our ethnic sub-population.

In current study, commonly reported symptoms of exudative pleural effusion was chest pain in 115 (65.0%) patients followed by dyspnea in 113 (63.8%) patients, pleurisy in 97 (54.8%) patients, cough in 78 (44.1%) patients, chills in 71 (40.1%) patients and fever in 63 (35.6%) patients. Rehan M, et al.[7] reported the breathlessness in 82% patients, fever in 80% patients, cough in 77% patients, chest pain in 57% patients, dependent edema in 27 % patients, weight loss in 22% patients, hemoptysis in 18% patients and confusion in 8% patients. Both studies are reporting that chest pain, dyspnea, fever and cough are the most commonly reported symptoms in patients of exudative pleural effusion.

In current study, bacterial microorganisms were detected in 67 (37.9%) patients of exudative pleural effusion, among which most common was Staphylococcus aureus and Escherichia coli detected in equal number of patients i.e., 13 (19.4%), followed by Acinetobacter baumannii in 12 (17.9%) patients, Streptococcus pneumonia in 9 (13.4%) patients, Staphylococcus epidermidis in 6 (9.0%) patients, Pseudomonas aeruginosa in 5 (7.5%) patients, Enterococcus spp. in 5 (7.5%) patients and Enterobacter aerogenes in 4 (6.0%) patients. Porcel J et al.[12] reported the similar frequency (41%) and pattern of microorganism in pleural fluid. Reported microorganisms in pleural effusion were; Viridans streptococci 20.4%, Streptococcus pneumoniae 18.3%, Staphylococcus aureus 12.9%, Enterococcus faecalis 7.5%, (Escherichia coli 7.5%, Pseudomonas aeruginosa 4.3%, Proteus mirabilis 3.2%, Salmonella enteritidis 2.1% and Clostridium specie 2.1%. Another study by Abdollahi A, et al.[11] reported the lower frequency (11.7%) of positive cultures in pleural fluid but similar pattern of microorganisms. Reported microorganisms in pleural effusion were; Staphylococcus aureus 19.2%, Acinetobacter baumannii 16.4%, Escherichia coli 13.7%,

Streptococcus pneumonia 8.2%, Staphylococcus epidermidis 6.8%, Pseudomonas aeruginosa 4.8%, Enterococcus species 5.5%, and Enterobacter aerogenes 2.0%. All the studies are reporting that Escherichia coli, Staphylococcus aureus, Acetobacter baumannii were the most commonly detected microorganism in exudative pleural effusion followed by Streptococcus pneumonia, Staphylococcus epidermidis, Enterococcus spp., Pseudomonas aeruginosa and Enterobacter aerogenes.

CONCLUSION

It was concluded from the study that frequency of bacterial microorganisms in exudative pleural effusion was high among adult population. Frequency of Escherichia coli, Staphylococcus aureus, Acetobacter baumannii was high followed by Streptococcus pneumonia, Staphylococcus epidermidis, Enterococcus spp., Pseudomonas aeruginosa and Enterobacter aerogenes.

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AUTHOR CONTRIBUTIONS

Ali A: Planning of study, discussion writing
Ghuman FD: Abstract writing
Hasan SM: Data collection
Iqbal S: Literature review
Ahsan: Results writing
Adnan SM: Statistical analysis

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