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The Changing Patterns of Bacteriological Isolates of Community Acquired Pneumonia in Adults

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Abstract

Community-acquired pneumonia (CAP) in adult especially in elderly has different clinical presentation and higher mortality than CAP in other age group. Clinical presentation may vary from mere presence of fever to altered sensorium. The incomplete clinical picture of CAP in the elderly may be associated with a delay in establishing the diagnosis and, consequently, in starting adequate antibiotic therapy. The true incidence of pneumonia acquired in the community is unknown, but this is a common clinical problem worldwide especially in developing countries and remains a leading cause of death in India.There are very few and conflicting Indian data regarding the bacteriological etiology of community acquired pneumonia (CAP). Adding to this agony, there is no much credible data from the north-eastern part of India. Hence the following study was undertaken to study the clinical, radiological, and bacteriological profile of community-acquired pneumonia in adult. A total of 220 patients were studied. Age group varied from 18 years to 85 years. Presentation varied from typical symptoms to altered sensorium. Smoking and COPD were most common predisposing conditions. Most common organisms responsible were *Klebsiella pneumoniae*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Haemophilus influenzae*, *Streptococcus pneumoniae*. In the present study, gram negative organisms were more commonly isolated on sputum culture, so the empirical therapy in pneumonia should be directed also towards these organisms for a better outcome.

Keywords

Community acquired pneumonia, bacteriological profile, Klebsiella pneumoniae, Staphylococcus aureus, Pseudomonas aeruginosa, Haemophilus influenzae, Streptococcus pneumoniae

Introduction

Pneumonia is defined as an acute respiratory illness associated with recently developed radiological pulmonary shadowing which may be segmental, lobar or multilobar. Pneumonia is usually classified as Community Acquired Pneumonia (CAP) and Hospital acquired pneumonia (HAP) [1]. Around 20% of the mortality due to infectious diseases in India is caused by lower respiratory tract infections among which pneumonia is the most important culprit[2]. Bacteriological profile in community acquired pneumonia (CAP) is different in different countries and changes with time even within the same country. Looking at world literatures microbiological diagnosis could be made in only 40-71% of cases of CAP even when extensive methods have been used when compared to >90% cases in pre-antibiotic era [2]. The widespread antibiotic (mis) use is probably responsible for decreasing culture rates in CAP. The problem of pneumonia is much greater in developing countries where pneumonia is the most common cause of hospital attendance in adults [3]. It is a major cause of death among all age groups resulting in 4 million deaths (7% of the world's total death) yearly [4].The mortality ranges from 13.6% in hospitalized patients to 36.5% in patients admitted to ICU [5].

In India estimated death rate per 100,000 population in 2004 was 89.5% due to LRTI & estimated disability adjusted life years (DALYs) per 100,000 population in 2004 was 1894 [6].

Aetiology of CAP is generally bacterial but the microbial pattern varies from country to country. It varies with time and geographical distribution within the same country and so does the antimicrobial sensitivity and emerging resistance pattern. *Streptococcus pneumoniae* is the most common etiological agent in United Kingdom, Europe, United States of America and Iraq. In India *Streptococcus pneumoniae* is most common causative organism of pneumonia in Delhi, Shimla, Ludhiana and Pune [3,7, 9] .

In view of the above observations made by various workers, the present study is being conducted to know the causative agents of the CAP so that the patients are properly diagnosed and treated with specific antibiotics. Further, no similar studies have been carried out in this state. This study will also give us information regarding the occurrence, types of the causative bacterial agents & socio-demographic profile of adult onset CAP patients in a tertiary care hospital in this state.

Material and Methods

The present study was conducted at Department of Microbiology in collaboration with the Department of Medicine of AGMC & GBP Hospital between December 2017 and June2019. This study is a hospital based cross sectional study carried out on 220 cases of CAP patients aged $\geq$18years. Prior to the study, the protocol was approved by the institutional ethical committee, and all patients gave their informed consent to participate.

Patient demographic features were recorded according to a standard questionnaire. A detailed clinical history was taken. History for comorbid illness and habits like smoking and alcoholism were taken. A detailed clinical examination was carried out including general physical examination, vital signs, and respiratory system examination, mainly for signs of consolidation and other systemic examination for the comorbid illness. Routine

investigations like hemoglobin, total leucocytes count, differential count, ESR, random blood sugar, blood urea, serum creatinine, liver function tests, and serum electrolytes were sent. Radiological evaluation was done.

Sputum and bronchoalveolar lavage was collected for gram stain and culture and sensitivity, before starting empirical antibiotic therapy. Following gram staining those specimens were inoculated in Blood agar (BA), MacConkey agar (MA), Chocolate agar (CA). Inoculation in chocolate agar was done when pus cell count in direct gram staining was observed to be more than 50/hpf. The inoculated plates were incubated aerobically at 37°C overnight. The inoculated chocolate agar & sheep blood agar suspecting growth for Streptococcus pneumoniae however were incubated at 5-10% CO_2 (candle jar) with similar duration and temperature.

Statistical Analysis-Data was analyzed with SPSS version 20 & Microsoft Excel, 2013.

Results

The results and observations of the study are as follows.

Distribution of sample

During the study period 216 sputum samples and 4 bronco alveolar lavage samples were collected from a total of 220 study population(comprising of 122(55.45%) from IPD,75(34.10%) from OPD & 23(10.45%) from ICU) of community acquired pneumonia as per inclusion and exclusion criteria from medicine & chest department.

Distribution of study population according to severity score (CURB-65):145 samples were collected from patients admitted in hospital (IPD & ICU) based on their pneumonia severity score – CURB 65. (Figure 1)

Bacteriological examination of sputum

Macroscopic examination were performed to detect-

A. Color

B. Consistency

C. Volume

Different color &consistency of sputum samples are displayed in Table No.1 &2

Microscopic examination

Results of Sputum Gram Staining- The sputum smears were gram stained and examined under microscope for determination of their adequacy. Out of 216 sputum samples, 165 samples showed > 10 pus cells/epithelial cells under low power field in gram staining. Rest 51 sputum samples were recollected from patients and the adequacy of samples were revalidated. After validation of sputum samples bacteriological culture was done. Of those smears predominate organisms were, 39 (18.06%) gram positive cocci, 70 (32.41%) gram-negative bacilli, and 107 (49.54%) were mixed.

Bacteriological culture and isolation

220 samples were inoculated as per the protocol mentioned in 'Method & Material'. From the total sample size of **216 sputum samples**, 127 (58.80 %) were found to be culture positive for bacterial isolates & respiratory commensals grew in 89 (41.20 %) samples. Among the 127 culture positive samples, 81 (63.78%) and 46(36.22%) were GNB and GPC respectively. Out of the **4 BAL samples**, all (100%) were found to be culture positive, 1(25%) being GNB & the remaining 3(75%) were GPC.

The most common organism isolated from sputum culture was *Klebsiella pneumoniae* (n=44, 20.4%), followed by *Staphylococcus aureus* (n=35, 16.2%), *Pseudomonas aeruginosa* (n=18, 8.3%), *Streptococcus pneumoniae* (n=9, 4.2%), *Citrobacterkoseri* (n=9, 4.2%), *Escherichia coli* (n=5, 2.3%), *Citrobacter freundii* (n=3, 1.4%), *Streptococcus pyogenes* (n=2, 0.9%), *Haemophilus influenzae* (n=2, 1%), whereas the 4 BAL samples

comprised of *Klebsiella pneumoniae* (n=1, 25%) &*Staphylococcus aureus* (n=3, 75%). (Figure-2)

The colony morphology and gram stain of *Klebsiella pneumoniae* are shown in figure no.3,4.

** Sputum gram staining and culture demonstrated correlation in 109 of 216 patients (with both gram staining and culture positivity and 89 patients had respiratory commensal grown in culture)

Clinico-demographic profile

After completing and analyzing the proforma, clinico-demographic profile of the study population is determined. (Table no.3)

Symptomatology

In this study patients presented with both typical and atypical symptoms. Among the typical respiratory symptoms, cough was present in 198 (90%) patients, fever in 194 (88%) patients, dyspnea in 16 (35%), and pleuritic chest pain in 13 (29%) patients. Among the atypical symptoms altered sensorium was present in 3 (5.55%) patients and gastrointestinal symptoms of anorexia, nausea, vomiting, or diarrhea in 4 (8%) patients.

Predisposing conditions

In the study, chronic obstructive airway disease was the most common (35.8%), predisposing conditions. Other were cardiovascular disorders (16.7%), congestive cardiac failure (16%), diabetes mellitus (DM) (15.91%), renal failure (5.8%) and chronic liver disease (2.5%).Among habits, smoking was the most commonly noted in (54.5 %) patient, followed by alcoholism in (45.9%) patients.

Radiological Findings

Lower lobe of the right lung was most commonly involved (51.52%) in CAP followed by left lower lobe (15.91 %), right upper lobe (6.82 %), left middle lobe (6.06 %). Least commonly affected zone was left upper lobe (3.03 %). (Figure-5)

General Physical Examination findings

General physical examination of study population showed pallor in 20(9.09%), cyanosis in 6(2.73%), icterus in 4(1.82%), clubbing in 4(1.82%) and pedal edema in 3(1.36%) patients.

Vital Signs

In this study, raised temperature >38^{o}C was noted in 194 (88%) patients, in 130 patients it was 38.9^{o}c–39.9^{o}c, and 64 patients had 39.9^{o}c–40^{o}c, tachypnea (respiratory rate >24/min) was noted in 184 (84%) patients, tachycardia(pulse rate >100/min) was noted in 154 (70%) patients , hypotension (systolic blood pressure <90mmHg) was noted in 9 (4%) patients and hypothermia (temperature <35˚C)was in 5 (2.27%) patients.

Respiratory system examination findings

Crepitation were present in 90% of study population on chest examination. Other findings were reduced chest movements, impaired note on percussion, bronchial breathing and pleural rub.

Laboratory parameters

Leucocytosis (TLC>11,000/cumm) was the most common, noted in 176 (80%) patients. Anemia (Hb<11 gm/dL) was noted in 26 (12%) patients. ESR >20mmat 1 hour was noted in 167 (76%) patients. Blood urea >40 mg/dL was noted in 25 (11.36%) patients. Serum creatinine >1.4mg/dL was noted in 15 (6.8%) patients. Raised serum bilurubin greater >1.2mg/dL was noted in 5 (2.27%), and raised liver enzymes were noted in 4 (1.82%) patients. Hypoalbuminemia defined as serum albumin <3.5mg/dL was noted in 4 (1.82%), patients. Hyponatremia defined by serum sodium <130 meq/L was noted in 25 (11.36%) and hypokalemia was noted in 2 (5.45%) patients

Complications

The most common complication noted was septic shock in 20 (9%) patients, followed by pleural effusion in 12 (5.45%) patients. The other complications noted were congestive cardiac failure, ARDS, lung abscess, and emphysema.

Mortality

In our study, out of 220 patients, 198 (90%) patients improved and 22 (10%) patients had mortality.

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Discussion

CAP is a frequent cause of hospital admission and mortality in elderly patients worldwide. The clinical presentation, etiology, and outcome of community-acquired pneumonia in elderly differs from that of other population. In the present study, 80 patients of community-acquired pneumonia >60 years of age were included. The results of this study which has been presented in previously are discussed below.

Study population distribution

In our study 216 sputum samples and 4 bronco-alveolar lavage samples were collected from a total of 220 study population (comprising of 122(55.45%) from IPD, 75(34.10%) from OPD & 23(10.45%) from ICU) of CAP as per inclusion and exclusion criteria from medicine & chest department- which indicates a large number of CAP patients need hospitalization and even ICU admission.

According to one eastern Indian study conducted by Khadanga S et al, all of their CAP patients (464 no.) were hospitalized, among them ICU admission rate was 16.1% [10]. Our result coincide with their patient distribution.

Sputum Microscopy and Culture

In this study, the microbial diagnosis of CAP was confirmed by sputum culture only in 58.80% patients. This result is corresponding with Jain et al. study (45.8%) [11]. The overall rate of identification of microbial aetiology in other parts of India: 75.6% in Shimla [12],47.7% in Chandigarh [13],or other parts of world 62% in UK [14], 68% in Singapore [15] and 56% in Philippines [16].This could be due to the limited use of laboratory tests.

In this study, we used sputum, BAL culture and microscopy as diagnostic tools to identify the aerobic bacterial pathogen causing pneumonia. Serology for both atypical and viral pathogens was not done at the time of this study.

In this study 127 (58.80%) pathogens were isolated by sputum culture. But this is another fact that even with the use of extensive laboratory testing and various invasive procedures in different studies, etiological confirmation could be achieved only in 45-75% patients [8, 11-13, 17,18].

Decreased sputum positivity is due to prior use of antibiotics, inappropriate sputum production and non-productive cough.

Streptococcus pneumoniae has been identified as the commonest organism causing CAP all over the world [10, 19-26]. But some studies, over the last three decades, have reported higher incidence of gram-negative organisms among culture- positive pneumonias [3,27]. Most of the patients from whom gram-negative bacteria was isolated were over 50 years of age, smokers or had COPD. It has been reported that old age, smoking and COPD impair pulmonary defences and pre-dispose to CAP caused by gram-negative bacteria.

In this study most commonly isolated pathogen was *Klebsiella pneumoniae* accounting for 20.4%. Next common was *Staphylococcus aureus* which accounts for 16.20% this was followed by other Gram-negative bacilli – *Pseudomonas aeruginosa 8.30%, Citrobacterkoseri 4.20%, Escherichia coli 2.30%, Citrobacter freundii 1.40%* and *Haemophilus influenzae* 1%. *Streptococcus pneumoniae* and *Streptococcus pyogenes* was isolated in 4.20% and 0.9% of cases respectively.As per some Indian studies, over last three decades have reported higher incidence of Gram-negative organisms among culture positive community acquired pneumonia cases [3, 8, 11, 27-29].

The second commonest organism isolated from sputum culture was *staphylococcus aureus*. The high incidence of staphylococcus in CAP can be explained by spread of staphylococcus from hospital setting to community and staphylococcus complicating virus illness esp. influenza [8, 9].

Age distribution

Pneumonia is common in the extremes of age. In this study, the age group of patients presenting with CAP ranged from 18 to 85 years with a mean affected age is 56±3 years.

A study was conducted by Sandeep Kumar Jain at Gwalior in which they found 82 (68.3%) of CAP were elderly belong to >50 years age group with the mean age52.36 ± 16.77 years [10].

The increased incidence of pneumonia in elderly patients is due to the defects in mechanical clearance of airways, loss of elastic recoil of lungs, decreased strength of respiratory muscle causing decreased effectiveness of coughing, age related decline in mucociliary clearance, defects in humoral and cell-mediated immunity, and cumulative effects of comorbid chronic diseases and their treatments.

Predisposing Conditions

Smoking was the most important risk factor (54.5%) in our study. The increased risk of pneumonia in smokers is due to alteration in respiratory flora, mechanical clearance, and cellular defenses. Bacterial colonization of lower respiratory tract is more prevalent in smokers than nonsmokers, mucociliary clearance is defective in smokers, owing to a reduction in ciliary beat frequency and changes in volume and viscoelastic properties of respiratory secretions. In a population-based case-control study, Nuorti et al. found that cigarette smoking was the strongest independent risk factor for invasive pneumococcal disease [30]. In our study COPD was most common associated comorbid condition (35.8%). Increased incidence and mortality of pneumonia have been described in COPD patients. This is explained due to defective mucociliary clearance, mucous plugging, airway collapse, respiratory muscle fatigue, and the effect of medications used [31].

Presenting Complaints

Elderly patient may present with typical as well as atypical symptoms. Atypical symptoms are commonly described in elderly than in younger patients. The clinical presentation may consist of only an alteration of the patient's general condition, confusion, or decomposition of underlying disease [31, 32].

In this study patients presented with atypical presentations like altered sensorium, nausea, vomiting, diarrhea, loss of appetite, and breathlessness in addition to typical symptoms of cough, expectoration, fever, and pleuritic chest pain. Cough was the most common respiratory symptom noted in 198 (90%) patients, which was productive in only 120 (60%) patients, due to decreased ability of elderly to bring out the sputum.

Radiological Presentation

The radiological data in our study showed a predominance of lobar pneumonia in 180 (82%) patients followed by bronchopneumonia in 40 (18%) patients, most common lobe involved in this study was right lower lobe (51.52%). A study was conducted by Jain et al. in which they also noticed 80% study population had lobar pneumonia with most commonly involved segment was right lower lobe of lung (48.3%) [11].

Complications

Various complications noted in our study are septic shock 20 (9%), pleural effusion 12 (5.45%), ARDS 4 (1.82%), lung abscess 15 (6.82%), emphysema 3 (1.36%), and

decompensation of heart failure 4 (1.82%) patients, which is similar to Bilal bin Abdullah et al. study [31].

Mortality

In this study, 22(10%) patients had mortality. Mortality rates for elderly patients hospitalized with CAP in previous reports range from 6 to 40% [31] [33]. Along with associated comorbidities and malnutrition, increased age itself is an independent risk factor for increased mortality for CAP in elderly. Kaplan *et al.* reported a mortality of 11% in elderly patients with community-acquired pneumonia [34].

Conclusion

The study concluded: *Klebsiella pneumoniae* was the most common pathogen incriminated in CAP, followed by Staphylococcus aureus. In general the emergence of the higher incidence of Gram-negative organism especially *Klebsiella pneumoniae* has occurred in our geographical area.

Typical symptoms (cough, expectoration, and dyspnea) were common in both young and elder age group patients, but atypical symptoms e.g. altered mental status was commonly found in the elder population. A practical conclusion of clinical interest is that an effort has to be made to take chest radiographs, to exclude the possibility of pneumonia in elderly patients presented in hospital with delirium. Chest x-ray film showing infiltrates is necessary to establish the diagnosis of pneumonia. But radiographic changes usually cannot be used to distinguish bacterial from the nonbacterial pneumonia. Thus our study will enhance the importance of advising culture and sensitivity of CAP patients among clinicians.

Adult onset CAP is a life threatening condition & hence appropriate microbiological diagnosis & appropriate antibiotic therapy is essential to reduce the mortality and morbidity of patients. This will also prevent indiscriminate use of antibiotics what will lead to wide spread emergence of multidrug resistant pathogens which is alarming problem globally, nationally & regionally. Proper & accurate management of the adult onset CAP will also reduce the economic burden in the hospital & in the family of the patient. As in this present study, gram negative organisms were more commonly isolated on sputum culture, so the empirical therapy in pneumonia should be directed also towards these organisms for a better outcome.

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Color of sputum	No. of sample	Percentage (%)
Yellowish	35	16.20
Bloody (current-jelly)	55	25.46
Brown	16	7.41
Whitish	110	50.93
Total	216	100

Table No.1:- Different color of sputum samples

Consistency of sputum	No. of sample	Percentage (%)
Mucoid	75	34.72
Mucopurulent	41	18.98
Viscous	100	46.30
Total	216	100

Table No.2:- Different consistency of sputum samples

Socio-demographic profile	Study population	Percent
Age group (years)		
18-60 years	140	63.6
>60 years	80	36.4
Total	220	100.0
Sex		
Male	153	69.5
Female	67	30.5
Total	220	100.0
Occupation		
Farmer	45	20.5
Business	39	17.7
Government employee	41	18.6
Private sector employee	6	2.7
Student	20	9.1
Housewife	30	13.6
Pension holder	39	17.7
Total	220	100.0
Religion		
Hindu	199	90.5
Muslim	16	7.3
Others	5	2.3
Total	220	100.0
Marital status		
Married	181	82.3
Unmarried	39	17.7
Total	220	100.0
Family income per month		
Up to Rs. 5000	45	20.45
Rs 5001 to 10000	97	44.09
Rs 10001 & above	78	35.45
Total	220	100.0

Table No.3: Distribution of participants according to socio-demographic characteristics

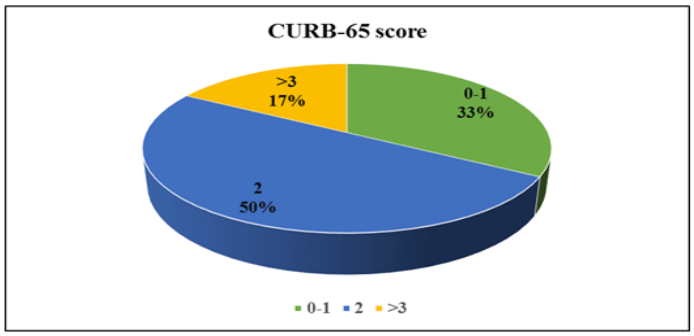

Figure-1: Pie chart showing distribution of CURB 65 Score of the study population

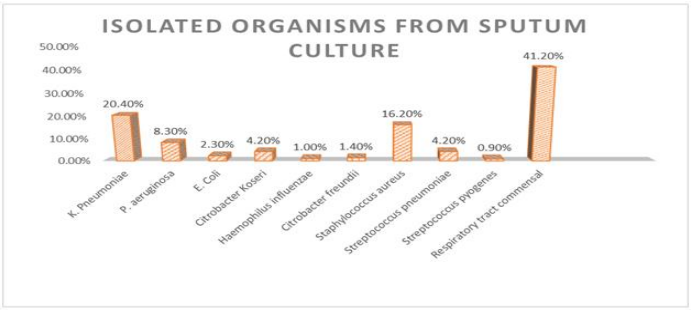

Figure-2: Bar diagram showing distribution of study population according to isolated organisms from sputum culture

Figure 3: Colony morphology of Klebsiellapneumoniae in MacConkey agar media showing pink colouredmucoid large colony

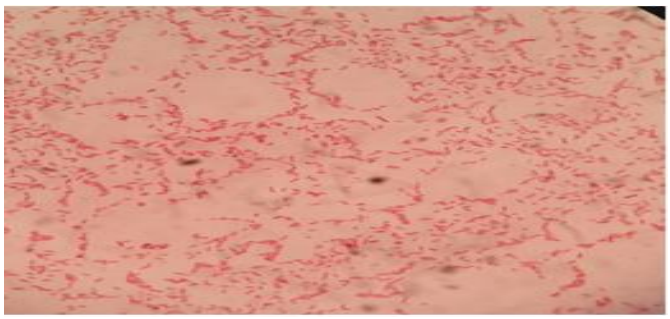

Figure-4: Gram staining finding showing gram negative short stout bacilli (1000x)

Figure-5: X-ray chest (AP view) showing involvement of right lung field in pneumonia