Seasonal incidence of community acquired pneumonia and its mortality in Karachi - A multi-centric hospital based study
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ABSTRACT

Community acquired Pneumonia is a frequent infectious disease in our country having a high occurrence rate. It causes high fatality at the extremes of ages in the population. Hence, a detailed study has been attempted to study the differences among patients’ outcomes with community acquired pneumonia hospitalized for acute infection during different seasons of the year. It is a retrospective, observational hospital-based study. This study was conducted in three tertiary care hospitals in Karachi, Pakistan (JPMC, AKUH and LNH) for a period of two years (2010-2011). All patients having a primary diagnosis of CAP admitted to the hospitals for treatment of acute infection were included in the study. Monthly and seasonal trends, causative agents and mortality rates of these patients were taken into account while hospitalized. Thirty six percent of the CAP cases occurred in the winter season and only eighteen percent in the autumn season. Respiratory viruses were found to be more frequent in the winter and spring, whilst Mycoplasma Pneumonia CAP reached its peak incidence of forty five percent in the spring compared to fourteen percent in the winter season. Other etiologies of CAP included in the study did not show any significant seasonal predominance. Males in the age group of 45 and above had higher mortality rates compared to other age groups (p=0.001). Winter, with its low temperatures and other co-existing conditions prevalent in the elderly population has significant contribution in causing increased admissions and expiries in this age group. Also, the respiratory viruses show increased inclination in causing CAP and therefore, demonstrate tropism for the winter season.

Keywords: Community acquired Pneumonia, season, weather, outcome, mortality.

1. Introduction

The increase in the health care burden from pneumonia is noticeable especially in the developing countries. It causes high mortality especially in the elderly people. Community-acquired pneumonia is one of the important cause of sickness and fatality in the United Kingdom (Caroline L, 2008), particularly for elderly adults. Although a majority of the cases of Community acquired Pneumonia are treated on outpatient basis; a minority of cases require hospitalization which leads to significant morbidity, mortality and health care expenses. Therefore, these groups of hospitalized patients form a key point of focus for studies on pneumonia. In recent years, there is an increase trend in hospital admissions for pneumonia in the United States (Fry AM, 2005; Hebert PL, 2005) and other European countries of Denmark and Netherlands (Thomsen RW, 2006; Oosterheert JJ, 2004).
This increase is attributed to the rise in the proportions of the elderly population and the prevalence of co-existing chronic conditions like diabetes mellitus and chronic obstructive pulmonary disease. These factors could explain in part the increasing hospitalizations for Community acquired Pneumonia (Hebert PL, 2005). Seasonal trends in hospital admissions for pneumonia is studied in some African settings (Tornheim J, 2007). Being a common infectious disease and a leading cause of mortality, its seasonal variation has a great epidemiological significance. Many studies have investigated the outcome of weather conditions on different upper and lower respiratory tract infections in the temperate countries (Dowell S, 2003; Kim P, 1996).

Despite the high prevalence of community acquired pneumonia, the seasonal distribution of the disease and its causative etiologies is not well-documented in literatures across the world (D. Lieberman, 1996). Also, only a small number of studies have related to the seasonal incidence of the disease in our country. Therefore we carried out this study to determine the baseline incidence of Community acquired Pneumonia, its seasonal variation and its mortality at tertiary care hospitals of JPMC, AKUH and LNH in Karachi, Pakistan so that changes in disease pattern can be recognized in the future.

2. Materials and methods

We conducted a Retrospective, hospital based study to assess the seasonal patterns in hospital admissions for patients who were hospitalized with a primary diagnosis of Community acquired pneumonia in Jinnah Post Medical Centre (JPMC), Liaqat National Hospital (LNH), and Aga Khan University Hospital (AKUH), Karachi for a two year period from January 1, 2010 to December 31, 2011. Data were collected from hospital Records Department through patients discharge file of those who had a primary diagnosis for CAP.

Patients were included in the data analysis if they had a primary admission diagnosis of pneumonia irrespective of the gender, race, or residence. All the patients who were not been treated in JPMC, AKUH, and LNH were excluded from the criteria. Admissions were restricted to those who made to the ward and the intensive care units. Emergency department and in patient visits were excluded from the study. Pneumonia admissions for age group (1-10 years) were also excluded from the study.

Data records obtained included variables as month of admission, month of discharge, year of admission, sex, age, outcome and blood culture reports of patient and were analyzed. The study age group for age was further divided into three age groups (11-19years, 20-44years and above 45 years) and the outcome into four different groups (expired, discharge, LAMA, shifted). Any pronounced increase in hospitalizations during different season of the year in relation with age and gender of patients and monthly admissions rate were analyzed. The hospitalization frequency in pneumonia admissions for the two years period was also observed.

Climate data was obtained from Pakistan Meteorological Department and analyzed. This climatic data included mean daily temperatures and relative humidity for the study months. As for seasonal variations in hospital admissions, winter is defined as Mid of December-February; summer is defined as Mid of April-June, spring is defined as March-Mid April, monsoon as July- September and autumn as November-Mid December.
2.1 Statistical analysis

For the comparison of categorical variables, Chi-squared test was performed to determine the significance of difference between different variables. A p-value of <0.05 was considered significant. All the analysis was performed using SPSS version 16.0.

2.2 Ethics

Before starting the study, proper permission was taken from all the Head of the Departments’ of all Chest Medicine Wards’ of the three hospitals’ from which data were retrieved for use in this study.

3. Results and discussion

There were total 925 patients analyzed during two year period (2010-2011). Over the two year study period, a sharp rise was observed in the month of November (autumn) with the clustering of cases occurring from Mid of December to February (Winter season), and a peak occurring in the month of January (Winter; figure 1). The months from March till may have relatively low rates of hospitalizations of CAP. There was an average of 77 admissions per month during the study period analyzed.

![Figure 1: Shows the number of monthly hospitalizations in each hospital](image)

The distribution of age for pneumonia related hospital admissions are illustrated in Figure 2 which shows admissions for age group 11-19 years (N= 71; 7.7%), for age group 20-44 years(N=237; 25.6%) and for age group above 45 years (N=617; 66.7% ). This clearly shows that greater numbers of hospital admissions were attributed to the age group of above 45 years(p=0.001) followed by age-group of 20 to 44 years, with the age group of 11-19 year, contributing the least (Figure 2).The mean age for pneumonia hospital admissions was found to be 75 years with the standard deviation of 1.92. When stratified by gender, the number of hospital admissions for males were (N=586; 63.4%) and for females (N=339; 36.6%). This clearly illustrates that male subjects for all age groups had significantly higher hospital admissions as compared to female subjects(p =0.001) (Figure 2). The sex ratio for pneumonia hospital admissions is about 172 male admissions for 100 female admissions.
The overall mortality rate observed during two year period is shown in Figure 3. There were 255 expired cases (27.6% of all hospitalized patients). The expired cases showed predominantly increase in the age group of above 45 years and male gender.

Table 1 shows the frequency distribution of the various casual agents for community acquired pneumonia among the 925 patients hospitalized with this diagnosis during the course of the study months. In all, the causal agent was identified in 905 patients (97.84%). A single etiology was found in 425 patients (45.94%), while more than one etiological agent was found in 500 patients (54.06%).

Table 1: Shows the frequency distribution of community acquired pneumonia (CAP) etiologies in 925 patients.

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Number of patients</th>
<th>% of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pneumococcus</td>
<td>346</td>
<td>37.40</td>
</tr>
<tr>
<td>Mycoplasma pneumoniae</td>
<td>204</td>
<td>22.05</td>
</tr>
<tr>
<td>Chlamydia pneumoniae</td>
<td>139</td>
<td>15.07</td>
</tr>
<tr>
<td>Legionella spp.</td>
<td>26</td>
<td>2.81</td>
</tr>
<tr>
<td>Respiratory Viruses</td>
<td>56</td>
<td>6.05</td>
</tr>
</tbody>
</table>
Table 2 shows the frequency distribution of CAP and its primary etiology by season. Thirty six percent of the cases occurred in the winter season, while only eighteen percent were seen in the autumn season. Viral etiology was found to be particularly prevalent in the winter and the spring (48% and 35%, respectively), with relatively low incidence in the summer and the autumn season (15% and 2%, respectively).

**Table 2**: Shows the frequency distribution of total community acquired pneumonia (CAP) and its etiologies by seasons

<table>
<thead>
<tr>
<th></th>
<th>Autumn</th>
<th>Winter</th>
<th>Spring</th>
<th>Summer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total CAP</td>
<td>925</td>
<td>18</td>
<td>36</td>
<td>26</td>
</tr>
<tr>
<td>Pneumococcus</td>
<td>346</td>
<td>24</td>
<td>32</td>
<td>21</td>
</tr>
<tr>
<td>Mycoplasma</td>
<td>204</td>
<td>20</td>
<td>14</td>
<td>45</td>
</tr>
<tr>
<td>Chlamydia</td>
<td>139</td>
<td>17</td>
<td>30</td>
<td>25</td>
</tr>
<tr>
<td>Legionella spp</td>
<td>26</td>
<td>26</td>
<td>22</td>
<td>20</td>
</tr>
<tr>
<td>Respiratory</td>
<td>56</td>
<td>2</td>
<td>48</td>
<td>35</td>
</tr>
<tr>
<td>Unknown etiology</td>
<td>20</td>
<td>19</td>
<td>32</td>
<td>35</td>
</tr>
</tbody>
</table>

Table 3 presents data relating to mean daily temperatures and relative humidity obtained from the Pakistan Meteorological Department for the study months in which the study was conducted.

**Table 3**: Shows the mean daily temperatures and relative humidity in Pakistan Meteorological Department, during the months of the study

<table>
<thead>
<tr>
<th>Month</th>
<th>Mean Daily Temperature (°C)</th>
<th>Mean Relative Humidity At 0000 UTC (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>2011</td>
<td>2010</td>
</tr>
<tr>
<td>Jan</td>
<td>20.5</td>
<td>19.9</td>
</tr>
<tr>
<td>Feb</td>
<td>23.1</td>
<td>22.0</td>
</tr>
<tr>
<td>Mar</td>
<td>26.9</td>
<td>27.7</td>
</tr>
<tr>
<td>Apr</td>
<td>29.9</td>
<td>30.5</td>
</tr>
<tr>
<td>May</td>
<td>32.2</td>
<td>32.3</td>
</tr>
<tr>
<td>June</td>
<td>32.2</td>
<td>31.5</td>
</tr>
<tr>
<td>July</td>
<td>31.3</td>
<td>31.5</td>
</tr>
<tr>
<td>Aug</td>
<td>30.3</td>
<td>30.2</td>
</tr>
<tr>
<td>Sept</td>
<td>29.6</td>
<td>30.2</td>
</tr>
<tr>
<td>Oct</td>
<td>29.3</td>
<td>29.9</td>
</tr>
<tr>
<td>Nov</td>
<td>25.0</td>
<td>25.1</td>
</tr>
<tr>
<td>Dec</td>
<td>21.3</td>
<td>19.6</td>
</tr>
</tbody>
</table>
The seasonal distribution of CAP was studied over a two year period in relation to the age, sex and outcome of the patients. All the patients who form a part if this study were hospitalized and this being a multi-centric study covers most of the population of this city corresponding to all the social classes. The study lasted for twenty four months which enabled us to present the seasonal distribution and mortality for two years in retrospect. Pneumonia mortality is subject to seasonal variations associated with outbreaks of influenza and variation with winter temperatures. Pair of studies (Fransen H, 1970; Foy HM, 1970) who have reported the seasonal incidence of the disease have stated that the peak distribution does not remain the same for two identical years. Since, in our study the distribution remained the same, we augmented the data of one year with the other and presented it in a single equation.

Although, we included the seasonal distribution of the infectious etiology in our study but due to the design of the study being retrospective, it is probable that the seasonal peaks reflect the epidemic with seasonal outbreaks in certain seasons during each of the epidemic years.

The geographical area in which the study was carried out i.e. Karachi; is relatively hotter during most of the year with its summer season divided into two zones during the year. However, the hospitalizations started to increase in the month of November and declined in February; which is distinctly winter months in this geographical locale. A number of patho-physiologic mechanisms have been proposed to explain the association of a sudden drop in temperature and acute respiratory infection. These include a reduction in the local immune response characterized by reduced phagocyte activity. The action of phagocytes in destroying viruses and bacteria is a major component of the non-specific immune response that is vital to prevent infection (Roit I, 1994; Salman H, 2000). The failure of phagocytosis is exacerbated by the activation of latent sub-clinical infections in the population; hence, the abrupt increase in frequency of acute respiratory infections that typically follows a sudden fall in temperature (Van Loghem JJ, 1928). Also, other factors such as remaining more time indoors in dwellings with poor ventilation and indoor pollution may promote the risk of acute respiratory infections.

MARRIE et al. (Marrie TJ, 1985) described CAP patients hospitalized over a period of 5 yrs. In this study, it was found that the seasonal frequencies for the monthly distribution of these cases were almost identical. While, FRANSEN (Fransen H, 1970), reports the number of hospitalizations by month for each of the 3 study years. The peak of hospitalizations for CAP was observed in the spring, late spring early summer and winter seasons. FOY et al. (Foy HM, 1970) studied the occurrence of pneumonia over a successive 5 year period. It was observed in the study that three annual peaks occurred in the spring and two occurred in the winter. However, in our study, we found that the increase was in the winter months rather than in the spring season found in different studies. In other studies, in which the peak incidence was obtained in the winter season conform to the results in our study.

The six respiratory viruses that we investigated in our study as causative agents for CAP had significantly higher incidence in the winter and the spring season, a low incidence in the summer, and were almost not found in the autumn. This is consistent with data showing that influenza A and influenza B, which caused most of the respiratory viral infections in the present study, reach peak incidence in the winter and spring (Macfarlane J, 1987). The incidence of M. pneumonia CAP has been observed throughout the year as studied in the literatures (Mansel JK, 1989; Atmar RL, Greenberg SB, 1989; Luby JP, 1991; Denny FW, 1971; Levine DP, Lerner AM, 1978; Takakura I, 1988; Johnson DH, Cunha BA, 1993). Seasonal peaks have been reported in only some of these studies. These peaks have been
reported in varying periods ranging from the end of summer to winter (Mansel JK, 1989; Johnson DH, 1993). This also matches with our study. In the present study, we observed the highest seasonal peak in the winter season, with a gradually decreasing incidence as the spring season approached. The early appearance of a seasonal peak in this study may be due primarily to the relatively cold climate during that period in our region, which is reflected by the distribution of seasons as shown in the meteorological data of this region. It was found that there was a higher incidence of pneumococcal CAP in the spring compared to the other seasons of the year. This incidence is similar to the higher incidence of pneumococcal infections in the spring observed by FRANSEN (FRANSEN H 1970) Two significant causal agents of CAP, *Legionella* species and *C. pneumonia* species had the same distributions of occurrence all over the year. This is consistent with previous reports concerning CAP caused by *C. pneumonia* (Kleemola M, 1988; Saikku P 1992) and *Legionella* spp. (Reboulet V, 1992; Falcó V, 1991).

The results obtained showed greater number of hospital admissions in the elderly males aged above 65 years which is consistent with the other studies (Gutierrez F, 2006). In this stage of life a person is known to have the occurrence of chronic and weakening conditions, which have a greater tendency towards males and have been found to be a major risk factor for community-acquired pneumonia (Almirall J, 1999) It is also thought to be related to underlying conditions, such as alcoholism and smoking, which are more common in males. Older people tend to be more at risk of developing pneumonia because of changes in their immune system. As they get older, their immune systems become weaker. Older people are especially observed to have the higher occurrence of CAP which is related to viral infections and Pneumococcus and *Chlamydia phila* species. (Gutierrez F,2006). The occurrence of infections with *Legionella pneumophila* has also been observed in the elderly males.(Gutierrez F,2006).On contrary, pneumonia caused by *Mycoplasma pneumoniae* has no relation with the sex and age of the patient (Gutierrez F,2006).

Our study also shows that the overall mortality rate during the two years studied is 27.6% of all hospitalized patients. Pneumonia is generally considered a main cause of morbidity and fatality at the extremes of ages (Loeb M, 2003). Increased mortality in the older age- groups may be attributed to their decreased potential to fight infections due to reduced immunity. Mortality was higher in men than in women which was also observed in study from Switzerland (Kaplan V, 2002).This may be attributable to increased tobacco smoking, alcohol consumption, co-morbid and immunosuppressant (Ali H, 2004) which is more pronounced in males as compared to females.

### 3.1 Limitations

Care was taken to bind the number of limitations in our study. Some of the limitations need to be described while interpreting the findings which are as follows: we relied on the physician diagnosis of CAP. This may have resulted in some inaccuracies in patient selection. Also, retrospective study design was used, significant differences in admission decision making may have existed among individual physicians.

### 4. Conclusion

In our hospital settings, we found increased incidence of hospitalizations and clustering of cases in the spring and winter seasons. Thus, winter with its low temperature can be said to be the main reason for development of CAP in this season but most of the specific etiologies documented in the study with the exception of Respiratory Viruses and Chlamydia
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pneumoniae. The admission rates due to specific etiologies of CAP were found to be highest in the elderly people above the age of 45 years. Male sex was more commonly involved in hospitalizations due to Cap. Also, the age group of 45 and above had the highest mortality rate compared to other age groups in the study. More studies should be undertaken to assess the apparent increase in pneumonia mortality in the elderly to reflect the epidemiolocal changes.

5. References


