Outbreak of Pneumococcal Pneumonia among Military Recruits

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Abstract

Background: Between 04 Mar 2002 to 21 Mar 2002, 31 cases of pneumonia were admitted at a military hospital in South India. Most of these cases were young recruits. The outbreak was investigated to ascertain the cause and suggest preventive measures. **Methods:** Detailed epidemiological history was taken from all 31 cases and 100 controls. Case sheets, laboratory reports and chest radiographs were studied. Laboratory investigations included sputum examination by Gram stain and blood cultures on brain heart infusion broth. Cultures grown on liquid media were subcultured on solid media. The regimental centre was visited to note the living and environmental conditions.

Results: Epidemiological investigations revealed overcrowding in the regimental centre. The space per recruit was below recommended standards. 51.6% of recruits who contacted pneumonia were sleeping on double deckers as compared to 21% of healthy controls. Blood culture was positive for *Streptococcus pneumoniae* in 25.8% of the cases. Chest radiograph showed consolidation typical of lobar pneumonia in 67% of the cases.

Conclusion: The outbreak of pneumococcal pneumonia occurred due to overcrowding. Chilly weather conditions and stress were contributing factors.

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Key Words : Military recruits; Outbreak; Overcrowding; Pneumococcal; Pneumonia

Introduction

In general population of developed countries, pneumococcal pneumonia is common in extremes of age. Annual incidence in young adults is estimated at 25 per 100,000 as compared to 280 per 100,000 in elderly individual [1]. Reliable data for developing countries are not available.

Between 04 Mar 2002 to 21 Mar 2002, 31 cases of pneumonia (mostly recruits) were admitted to a military hospital in South India. The outbreak was investigated by a team of specialists from Armed Forces Medical College Pune, Command Hospital(Air Force) Bangalore and Military Hospital Wellington.

Material and Methods

A detailed epidemiological history (including history of movements, camps, route marches, sleeping arrangements, etc) was taken from all 31 cases and 100 controls (25 randomly selected recruits from each of the 4 training companies who were not affected). Case sheets, lab reports and chest radiographs were studied. Besides routine haematological

and biochemical tests, laboratory investigations included sputum examination by Gram Stain and blood culture. All 31 cases were subjected to blood cultures (blood was drawn prior to administration of antibiotics). 2-3 ml venous blood was inoculated into 30 ml brain-heart infusion broth and incubated at 37°C. The specimens were subcultured on to blood agar plates every 48 hours. Smears from the broth were made and stained with Gram's stain. All the cultures grown on liquid media at Military Hospital, Wellington were brought to Department of Microbiology, Armed Forces Medical College, Pune by the investigation team for further identification. All the samples were subcultured on blood agar plates and incubated at 37°C with 5% CO₂. Confirmation for *Str pneumoniae* was done by morphology, cultural characteristics, catalase test, optochin sensitivity, bile solubility, inulin fermentation and animal pathogenicity in mice. The pneumococcal isolates were evaluated for antibiotic sensitivity by disc diffusion test. Further analysis by random amplified polymorphic DNA(RAPD) typing of the isolates was carried out. The investigation team also carried 500 ml of viral transport medium and sterile screw capped plastic containers. Throat washings of all admitted patients and some

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OPD patients with respiratory symptoms (n=40) were collected in 2 ml viral transport medium along with antibiotics in screw capped sterile vials and labelled. Serum samples of all patients admitted in the hospital were also collected for further serological studies. However, paired samples were not taken. The samples were sent to National Institute of Virology, Pune for detection of respiratory viruses namely paramyxo, orthomyxo and adeno viruses. Serum samples were also tested for cold agglutinins by double dilution method. Hospital records were studied for present and past trends of pneumonia.

The team visited the regimental training centre to elicit the strength, turnover, sickness rates and other relevant data. It visited the barracks and assessed the floor and cubic space available. Medical Inspection Room records were also reviewed for other respiratory group of diseases (possibly viral) besides pneumonia. Practitioners in the adjoining civil areas were interviewed. Meteorological data was noted.

Results

Clinical presentation : Most of the 31 cases suffered from preceding Upper respiratory infection (URI) (manifested by running nose, sore throat, hoarseness of voice and dry cough) ranging from few days to 2 weeks prior to admission. At the time of admission, most of the recruits had combinations of multiple signs and symptoms. 21 (67%) had moderate to high-grade fever, 18 (58%) had cough with expectoration and 17 (54.8%) had pain chest. 16 (51.6%) of the cases which went into septicaemia as manifested by high fever and/or marked hypotension, out of which 14 were put on dangerously ill list (DIL) and 2 on seriously ill list (SIL).

Radiographic findings: Radiologically, there was consolidation typical of pneumonia in 21 (67%) cases (sites of consolidation were-right upper lobe 1; right middle lobe 3; right lower lobe 7; left lower lobe 10). 6 patients had features suggestive of bronchopneumonia, while chest radiograph was normal in 4 cases.

Laboratory investigations: (a) Blood culture: Out of the 31 samples, 8 blood cultures showed Gram positive diplococci morphologically resembling *Streptococcus pneumoniae* in brain-heart infusion broth by Gram stain. On subculture of these samples on blood agar plates at Armed Forces Medical College, two could be recovered and were confirmed as *Streptococcus pneumoniae* by morphology, cultural characteristics, catalase test, optochin sensitivity, bile solubility, inulin fermentation and animal pathogenicity in mice. Both the pneumococcal isolates were found to be sensitive to penicillin, erythromycin, cefotaxime, chloramphenicol and tetracycline by disc diffusion tests. Analysis by RAPD typing of the isolates showed that they belonged to the same strain. (b) Sputum smears: All the sputum smears available were reviewed. Out of the available 26 smears, 11 showed Gram positive diplococci morphologically resembling *Streptococcus pneumoniae* as the predominant organism. (c) Haematological parameters: The blood smears were reviewed by the investigating team and showed polymorphonuclear leukocytosis in 15 out of

the 31 patients ranging from 12,000 to 22,600/cumm. All blood culture positive patients had polymorphonuclear leukocytosis. Toxic granules could be demonstrated in only 2 patients. 5 patients showed normal counts despite having severe clinical manifestations. (d) Biochemical parameters: These were within normal limits. (e) Virological studies: All samples were negative for respiratory viruses namely paramyxo, orthomyxo and adeno viruses by culture, immunofluorescence and serology. (f) Cold agglutinins: All the serum samples were found to be negative for cold agglutinins (provisionally excluding mycoplasmal pneumonia).

Delay in seeking treatment : Average delay in seeking treatment for symptoms was 4.5 days. 8(24%) of the cases delayed treatment for more than a week because of fear of relegation.

Case management : Pending isolation of specific organisms, confirmation of aetiology and in view of the fact that a large proportion of patients (51.6%) presented with marked hypotension indicating septicaemia, all the cases were managed with broad-spectrum antibiotics either singly or in combination covering both gram positive and gram negative organisms (Cloxacillin, Cefotaxime, Gentamicin, Amikacin, Vancomycin and Ampicillin). All the patients responded to treatment and there was no mortality.

Place and person distribution

The regimental centre has 4 training companies. These, along with approximate strengths on 21 March 2002 are as follows:

(a) 'A' Company	635	these two barracks were
(b) 'B' Company	546	adjacent
(c) 'C' Company	583	these two were located some
(d) 'D' Company	628	distance from above two
		companies (1 Km)

In each company there are 10 platoons. Platoon strength was about 60 (recently raised from 30 due to shortage of instructors).

The bulk of the cases (23 of the 31), admitted for pneumonia between 04 and 21 Mar 2002 at military hospital occurred in 'A' Company (Table 1). Twenty-seven (87%) of the recruits affected were between 0 to 12 weeks of training. 'A' Company contributed the maximum number of cases and also had the least floor and air space per recruit.

Time distribution

All the cases in the present outbreak were admitted between 04 and 21 Mar 2002. The first case (from 'A' Company) was admitted on 04 Mar 2002. The second case (the company havildar major (CHM) of 'A' company who had come in contact with the first case) was admitted on 08 Mar 2002. Except for one case from 'B' company and one soldier (both gave history of close contact with recruits of 'A' company), all the cases admitted till 19 Mar 2002 were from 'A' company. After 19th March few cases were reported from other companies.

Table 1**Floor and air space per recruit company-wise and number of cases of pneumonia contributed by each individual company**

Coy	Total barrack floor space (M ²)	Strength	Floor area* per rect (m ²)	Air space+ per rect (m ³)	No of cases of pneumonia	% of total cases
A	2185	635	3.44	10.49	23#	74.2
B	2185	546	4.002	12.19	5	16.1
C	2452.6	583	4.21	12.82	2	6.5
D	2452.6	628	3.91	11.90	1	3.2
Total	9275.2	2392	3.88	11.82	31	100

*Recommended floor space = 5 m² per person, + Recommended air space = 18 m³ per person, # 22 recruits.

Table 2**Proportion of cases of pneumonia giving history of sleeping on double deckers/floor as compared to controls without pneumonia**

History of sleeping	Cases of pneumonia	Healthy controls	Total
Double deckers/floor	16 (51.6%)	21 (21%)	37 (28.24%)
Single cots	15 (48.4%)	79 (79%)	94 (71.76%)
Total	31 (100%)	100 (100%)	131 (100%)

Chi square (Yates corrected) = 9.48, df = 1, p = 0.002 (significant)
 Odd's ratio = 4.01 (comfield 95% CL for OR = 1.58 < OR < 10.30)

State of accommodation and sleeping arrangements

The total barrack space available for accommodating the four companies along with the strength and space available per recruit are given in Table 1. 16(51.6%) of the recruits who contacted pneumonia, gave history of sleeping in the double decker cots, or on the floor because of unavailability of adequate number of cots. As compared to this, 21% of the healthy controls gave history of sleeping in double deckers or on the floor. This difference was statistically significant (Table 2). Such arrangements due to overcrowding further compromised the available floor and air space facilitating spread of respiratory infections due to droplet infection. Moreover, there were no fans, being a non-fan station.

Turnover and overall strength of the regimental centre

The strength of recruits of the training centre varied between 1463 in Jan 2001 to 1497 in Dec 2001. However, since Jan 2002 there was a sudden increase in new enrolments with 508 enrolments in Jan 2002, 249 in Feb 2002 and 349 in Mar 2002 (Table 3). Not only absolute number of recruits increased suddenly in the first quarter of the present year as compared to previous year but the monthly intake in the first three months of the present year was also very high. Whereas in the first quarter of previous year the total new enrolment for the quarter was 126, in the present year there were 1106 new enrolments - an increase of almost 10 times (Fig. 1).

Meteorological conditions

The regimental centre is located at an altitude of about 1,800 metres. The maximum temperature was between 17°C to 24°C in the months Jan to Mar 2002 and the minimum between 7°C to 14°C.

Present and past incidence of respiratory group of

Table 3**Monthwise strength along with monthly new enrolments Jan 01 to 20 Mar 2002***

Months and year	Total recruit strength	New enrolments
Jan 2001	1463	108
Feb 2001	1427	02
Mar 2001	1095	16
Apr 2001	1239	260
May 2001	1233	42
Jun 2001	1211	259
Jul 2001	1436	237
Aug 2001	1619	192
Sep 2001	1462	189
Oct 2001	1470	30
Nov 2001	1636	178
Dec 2001	1497	38
Jan 2002	1993	508
Feb 2002	2114	249
Mar 2002	2392	349

*The strength of recruits who have left in each month after completion of training has not been shown. Only strength in each month with new enrolments has been shown

Fig. 1 : Quarterly new enrolments Jan 01 to Mar 02 (upto mid Mar)

diseases (other than pneumonia) among the recruits

Besides pneumonia, there was also increase in other respiratory diseases reporting to the OPD such as common cold, bronchitis and URTI in the month of March as compared to previous year (Fig. 2).

Fig. 2 : Cases of other respiratory illnesses among recruits reporting to MI room (Jan-Mar 01-02)

Fig. 3 : Pneumonia cases 2002-2002 (Mar)

Previous incidence of pneumonia among recruits

In the year 2001 there were 11 cases of pneumonia among the recruits from Jan to Dec with 2 cases occurring in March. During 2000 there were 30 cases with 6 cases in March (Figure 3). No bacteriological confirmation could be established in earlier years. The cases of pneumonia per 1000 recruits in the months of March 2000-2002 is shown in Figure 4. The number of cases in Mar 2002 is clearly in excess of normal expectations as compared to the preceding two years (Figure 4).

Disease rate in neighbouring civil population

There was no unusual incidence of pneumonia like illness among the civil population.

Control measures

Overcrowding was reduced in barracks, classrooms and dining halls. Contacts were segregated and administered either Erythromycin or Azithromycin for five days (Erythromycin 250 mg twice a day and Azithromycin 250 mg once a day). As *Streptococcus pneumoniae* is found in the respiratory tract of healthy people [1], detection of carrier rates is of no practical value.

Discussion

Like many other microorganisms, *Str pneumoniae* colonizes the nasopharynx [1]. Appropriate culture yields pneumococci in 5-10% of healthy adults, which may rise to 40-60% in certain groups. An individual serotype persists usually 2-4 weeks, sometimes much longer [2].

Fig. 4 : Incidence of pneumonia among recruits in the month of Mar (2000-2002)

Population based studies carried out in different parts of the world [3], show that the overall rate of invasive pneumococcal disease, is about 15 per 100,000 persons per year. In certain populations and ethnic groups [4,5], the incidence may be increased 10 fold. It is a disease of continuing endemicity particularly in infancy and old age [6]. Day care centres are very likely to be places for spread of organisms in toddlers [7,8,9,10]. In military medical literature, there are accounts of pneumococcal outbreaks. Hodges et al [11], reported an epidemic in an Army Training School during World War II, where under conditions of overcrowding and high turnover of recruits, there were 1,600 cases of pneumonia over a two and a half year period. More recently, between 4 Mar to 8 April 1999, an Epidemiologic Consultation team of the US Army conducted an investigation of pneumococcal pneumonia outbreak in a cohort of Ranger students at Fort Benning [12]. During the first five weeks of training, there were 29 cases of pneumonia. The outbreak was controlled by mass azithromycin treatment.

In a large percentage of cases with acute respiratory infections, the pathogens responsible for infection are not known [13]. In community acquired pneumonia, the causative organism is unknown in approximately 98% of those treated as outpatients and 50% to 60% of those treated as hospital inpatients [14,15]. Studies of the bacterial causes of pneumonia have been marred by problems of contamination of sputum by nasopharyngeal and oropharyngeal organisms [16]. As bronchoscopic and transtracheal aspirates are also at risk of contamination [17,18], most investigators rely on percutaneous needle lung aspirates and blood culture for accurate diagnosis [9]. Blood cultures are positive in only 1 to 16% of patients, and their cost-effectiveness have been questioned [20,21]. In this outbreak we could isolate the etiologic agent in blood culture in 25% of the cases in liquid media. However, only in 6.45% of the cases the organisms could be confirmed on solid media. Because of this limitation, the etiologic role of

Streptococcus pneumonia in a patient who has pneumonia is strongly suggested by microscopic demonstration of large number of Gm +ve cocci in pairs and chains in sputum [1]. *Streptococcus pneumoniae* is associated with upto 70% of pneumonia cases in which a pathogen is isolated [22,23]. Though the conditions for mycoplasmal pulmonary infection was present in the barracks, the findings of the present study support the view that pneumococcal disease still remains the predominant cause of community acquired pneumonia. The chest radiograph is fairly reliable with low inter-observer variability [24,25,26,27]. Lobar consolidation, cavitation and large pleural effusions support a bacterial cause. Most lobar pneumonias are pneumococcal, whereas most pneumococcal pneumonias are not lobar [1]. In the present outbreak 21 (67%) of the cases had lobar pneumonia.

The floor and air space available per recruit were below the recommendations in the Manual of Health for the Armed Forces, which recommend 5m² of floor area and 18m³ of air space per person. In 'A' and 'D' company it was also below the norms recommended by WHO in emergency shelters, i.e., 4m² per person [28]. Correlation exists between overcrowding and pneumonia incidence [13]. The recruits in the present outbreak were exposed to chilly conditions and were undergoing stress of training. It is not clear whether meteorological factors per se increase host susceptibility or whether crowding is a concomitant variable [13]. Graham et al [29], studied the relationship between stress and respiratory infection. Stress was related to incidence of respiratory infections even after adjustment for confounders. Stress may suppress immune function [30].

Viral infections predispose to pneumococcal infections [1,11]. In this outbreak, rate of upper respiratory infections reporting was higher than previous figures. Though erythromycin/azithromycin prophylaxis was resorted to as one of the measures to control the outbreak, taking cue from an isolated reference [12], same is not mentioned in standard text [1,6,13]. This needs further evaluation. Vaccines have been recommended for prophylaxis [1,3,6]. However, because of differences in serotype prevalence, the vaccine may have lower efficacy in developing countries [6]. Research on prevalent serotypes in our population is needed. Meanwhile, overcrowding in military barracks should be avoided.

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