

Research Article

Lessons Learnt from a Pneumonia Outbreak in a Naval Training Establishment

Sundeep Bhandari

Brigadier (Earlier Surgeon Captain), VSM, India.

DOI: <https://doi.org/10.24321/2455.7048.202204>

I N F O

E-mail Id:

bhandari.sundeep@gmail.com

Orcid Id:

<https://orcid.org/0000-0002-0350-6993>

How to cite this article:

Bhandari S. Lessons Learnt from a Pneumonia Outbreak in a Naval Training Establishment. *Epidem Int.* 2022;7(2):1-5.

Date of Submission: 2021-12-15

Date of Acceptance: 2022-06-30

A B S T R A C T

Introduction: In August 2014, an unusually large number of cases of pneumonia was reported from amongst Naval Recruits in a Naval Training Establishment by the co-located Indian Naval Hospital Ship.

Material and Methods: The study was descriptive observational (retrospective) in nature, which was carried out at Indian Naval Training Establishment and Indian Naval Hospital Ship. The following information was collected: (a) Batch-wise comparison of data of recruits at Indian Naval Training establishment (where two major batches undergo training every year) was done for the occurrence year (2014) and the preceding 03 years i.e 2011, 2012 and 2013. Further, data on cases of pneumonia was collected from Indian Naval Hospital Ship as recorded by the hospital for last 03 years (2011, 2012 & 2013) and the year 2014, using an epidemiological format.

Results: (a) Overcrowding. (b) Confirmation of existence of Outbreak. (c) Distribution of cases as per symptomatology and X-ray findings. (d) Manmade overcrowding, physical and psychological stress of military training exposes non-immune persons to several pathogens. The study confirms overcrowding with per capita standard for floor space and air space being 5 sqm and 18 m³. The recommended distance between two adjacent beds is 1.8m. In fact, they were even below the standard of 4 sqm recommended by WHO. A positive Correlation is known to exist between overcrowding and incidence of pneumonia.

Conclusion: Batch-wise comparison of cases and incidence of LRTI/ Pneumonia confirmed the outbreak. Further, there were no cases of Pneumonia amongst training staff (officers & sailors) and other civilian in adjoining areas. Consequent to increase in induction pattern at Naval Training Establishment, coupled with absence of accompanying increase. Consequently, analysis of living conditions established that overcrowding existed in dormitories, dining areas and all facilities related to training.

Keywords: Pneumonia, LRTI, Azithromycin, Health

Introduction

In August 2014, an unusually large number of cases of pneumonia was reported amongst Naval Recruits in a Naval Training Establishment by the co-located Indian Naval Hospital Ship. Outbreaks have been reported in training establishments but this study was unique in understanding overcrowding, dynamics of disease transmission & institution of preventive measures including chemoprophylaxis. No documented study in this training establishment.

Aims and Objectives

- To establish increase in the number of cases of pneumonia as reported by the co-located Naval Hospital in 2014
- To establish factors responsible for this increase in the number of pneumonia amongst recruits
- To recommend preventive and control measures for reducing this increase in cases amongst recruits

Materials and Methods

The study was descriptive observational (retrospective) in nature, which was carried out at Indian Naval Training Establishment and Indian Naval Hospital Ship. The following information was collected.

Batch-wise comparison of data of recruits at Indian Naval Training establishment (where two major batches undergo training every year) was done for the occurrence year (2014) and the preceding 03 years i.e. 2011, 2012 and 2013. Data thus collected from the training Establishment included details of training pattern, batch inductions, living areas, dining areas, classrooms hygiene conditions, etc. Further, data on cases of pneumonia was collected from Indian Naval Hospital Ship as recorded by the hospital for last 03 years (2011, 2012 & 2013) and the year 2014, using an epidemiological format. Details of other cases of respiratory/airborne infections like Tuberculosis, Chickenpox, mumps and cases amongst other training staff (officers, sailors, civilians) at Naval Training Establishment was also noted in addition. Rounds of Naval training Establishment was taken for studying the various areas where recruits are trained.

The additional details collected included inputs from neighboring physicians/ hospitals at the station, Meteorological data for the station, Layout plan of Training Establishment, Status of works for accommodation for recruits (from Garrison Engineer), and other measures initiated for recruits training affecting health/hygiene.

Data for Pneumonia cases was taken from Medical Board Office, Indian Naval Hospital Ship with inputs from Medical Specialist & Anesthesiologist, using the following case definition: All cases having Fever, Cough, bronchial breath sounds/ crackles on auscultation, leukocytosis, X-ray chest showing consolidation / Non-Homogenous Opacities,

responding to appropriate antibiotics. Towards this end, all case sheets were obtained from the Naval hospital and entered in the epidemiological proforma for each case. The study of LRTI was systematized into not year wise but batch-wise, as there was a gap of three weeks between 02 batches. Thus, each batch was considered a separate group for study of LRTI / Pneumonia.

Subsequently, the period for data was expanded to include year 2011, since preceding three years data is mandatory for analysis to determine the control limits (Upper Control Limit/ UCL) for LRTI/ Pneumonia. Thereafter, this data was further split into batches for comparison (e.g. 01/2011, 01/2012, 01/2013, 01/2014 & 02/2011, 02/2012, 02/2013, 02/2014). As each batch was for 21 weeks in the year 2014, data of 2014 was considered for the following two periods: Batch 01 of a particular year: Feb - Jul, Batch 02 of a particular year: Aug - Jan. Upper Control Limits (UCL) for LRTI / Pneumonia was computed using the following formulae:

$UCL = R + 1.023 \times A$, where R = Average of incidence rate / 1000 for corresponding period of preceding 03 yrs, and A = Average of ranges for 03 years preceding 2014. In addition, Line listing was done for all the confirmed cases.

Indian Naval training establishment. Location, Layout and weather pattern: The training establishment was commissioned on 21 Feb 1980 and is situated alongside a lake. The base is spread over 1540 acres. The base has high temperatures (30-42°C) and high humidity levels (up to 85-90%).

Training Duration and Trend: The training duration of various batches ranges from 09 weeks (02 batches /year) for Artificer apprentices/Yantriks (Coast Guard) to 21 weeks (02 batches per year). Since the gaps between Senior Secondary Recruits (SSR) batches (main ones) has been increased from 2 weeks to 3 weeks, duration of training has reduced from 24 weeks to 21 weeks.

Infrastructure for Recruits: 05 blocks/dormitories with a capacity to accommodate 300 recruits each and 01 block with a capacity to accommodate 200 recruits (total 1700 recruits) exist. There are 03 dining halls - 01 for Non-veg (600 persons) and 02 for vegetarians (300 each) & at one time 1200 recruits can be taken for meals. There is one swimming pool and 09 swimming classes per day are conducted with 1300-1400 total recruits per day.

Overcrowding: While the designed capacity of the training amenities in the base is for handing an average of 1700 recruits per batch, with a change in induction pattern, the total recruits' strength has witnessed a more than two-fold increase, from an average of 1200 recruits per batch in the year 2007 to 2640 recruits per year in 2014. This has led to significant overcrowding, with no additional

infrastructure in place to accommodate the rising numbers. This overcrowding was observed in all the spheres of recruit-life at Indian Naval Training Establishment, be it living, training or allied amenities and attendant facilities. For instance, 52 classrooms with design to accommodate 25-30 recruits each were holding 50-55 recruits per class at the time of the study.

Further, the recommended standards¹ and actual details of standards of accommodation of recruits in dormitories is as shown in Table 1.

Table 1. Overcrowding in Dormitories: Comparison of Recommended Standards Vs Existing Conditions

Parameter	Recommended Standards ¹ (Unit)	Existing condition (calculated based on actuals)
Floor Area	5 m ² per individual	1.56 per individual
Air space	18 m ³ per individual	5.08 m ³ per individual
Distance between two adjacent beds (Centres)	not less than 1.8 m	1.25 m

With a strength of more than 2500/2600, the lunch has been staggered in 02 groups with a gap of 45 minutes. At dinner time there is no such gap & thus overcrowding is noticed.

III-ventilation: Scrutiny of Sanitary Diary revealed non-operational status of large proportion/ number of fans & exhaust fans every month, thereby adversely affecting the ventilation/air changes required in a dormitory, more so with overcrowding.

Results

Indian Naval Hospital Ship

The unusual increase in the Pneumonia cases amongst recruits of Naval training Establishment was reported by Naval Hospital adjacent based on the month-wise breakdown of case details for recruits and others (officers, sailors & civilians) for the years 2012, 2013 and 2014. It is noteworthy that in the other (non-recruit) group there were no cases of Pneumonia reported in 2014, while there was only 01 case in 2013. The cases have been documented by the medical specialist based on Fever, Cough, Leukocytosis and X-ray chest findings. No back up of microbiological facilities existed to confirm the incriminating agent.

Batch-wise break-up of numbers and incidence of pneumonia/LRTI cases for the year under study (2014) and the preceding 3 years is as depicted in Table 2.

Table 2. Batch-wise break-up of Case Numbers and Incidence of Pneumonia/LRTI Cases

Year	Batch 01 / Feb – Jul (Cases/Total strength = Incidence)	Batch 02 / Aug – Jan (Cases/Total strength = Incidence)
2011	8/2469 = 3.24 per 1000	03/2691 = 1.15/1000
2012	29/2642 = 10.9777/1000	23/2615 = 8.795/1000
2013	28/2465 = 11.765/1000	43/2591 = 16.596/1000
2014	87/2605 = 33.39/1000	07/2675 = 2.62/1000

Confirmation of existence of Outbreak. Using the formula mentioned in Materials and Methods above, Upper Control Limits for LRTI/Pneumonia was worked out as UCL (LRTI / Pneumonia) = (8.748/1000) + (1.023 x 9.33) = (8.748/1000) + (9.548) = 18.296/1000 (99% confidence interval). Thus, Batch 01/2014 with 87/2605 recruits = 33.39/1000 confirmedly constituted an outbreak, since its UCL crossed that for LRTI/ Pneumonia.

Distribution of cases as per symptomatology and X-ray findings.

Table 3. Distribution of Cases as Per Symptomatology and X-ray Findings

Symptom	Batch	Percentage
Fever	01/14	90.8%
	02/14	100%
Cough	01/14	98.9%
	02/14	100%
Leukocytosis	01/14	58.7%
	02/14	71.4%
Consolidation (X-ray)	Both batches	80%
Haziness, non-homogenous opacity (X-ray)	Both batches	20%
Response to antibiotics	Both batches	100%

Sequence of progression of the outbreak. Nil cases were reported in the first 02 weeks of training and there was an induction medical at the point of entry. As the training picked up, cases started. The Index case came to notice of the hospital on 13 Mar. High cases were reported in 16th week (14 cases) & 17th week (13 cases) of training out of 21 weeks.

Bacteriological confirmation was not possible with limited lab facilities and no Pathologist. During the previous years too, data had not conclusively confirmed the organism but

the outbreak of LRTI / Pneumonia cases were seen by the same Medical specialist (2011-2014). Leukocytosis was present in 60 - 70% of cases, which were nomenclature as Community Acquired Pneumonia (CAPs) based on their favorable response to antibiotics in all cases.

Based on the above-mentioned observations, it was concluded that the outbreak was a propagated outbreak with cases occurring over more than one incubation period of the disease (LRTI/Pneumonia) with person-to-person transmission.

Discussion

With the change in induction pattern in Naval training Establishment, overcrowding was faced in dormitories, classrooms & dining halls. Increase in pneumonia cases were reported by Naval hospital adjacent to this training establishment. Most pneumonia arise from the aspiration of oropharyngeal flora, normally a complex assortment of aerobic and anaerobic bacteria. *Streptococcus pneumoniae*, *H. influenza*, *S. pyogenes*, *Mycoplasma pneumoniae* and *Moraxella cantarrhalis* are found in the oropharynx of healthy adults.² 5-10% of healthy adults may carry pneumococci in their nasopharynx, which in certain groups may rise to 40-60% as is evident from nasal smear culture.³

Manmade overcrowding, physical and psychological stress of military training exposes non-immune persons to several pathogens. The study confirms overcrowding with per capita standard for floor space and air space being 5 sqm and 18 m³. The recommended distance between two adjacent beds is 1.8m¹ In fact, they were even below the standard of 4 sqm recommended by WHO.⁴ A positive Correlation is known to exist between overcrowding and incidence of pneumonia.⁵ Moreover, the stress to which the recruits are subjected during the course of their training may suppress their immunity and thus further predisposing them to infections.⁶

In large percentage of cases with acute respiratory infections, the pathogens responsible for infection are not known.⁷ In Community Acquired Pneumonia (CAP) the causative organism is unknown in approximately 98% of those treated as outpatients and 50-60% of those treated as hospital inpatients.⁸

With respect to Chemoprophylaxis as a means of outbreak control, between 4 March to 08 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. During the first five weeks of training, there were 29 cases of pneumonia. The outbreak was controlled by Mass Azithromycin treatment.⁹ The outbreak was controlled by administering low dose oral Azithromycin prophylaxis (250 mg weekly for 2 weeks)

and was associated with 69% reduction in pneumococcal carriage and a 94%, reduction in pneumonia rates.

Conclusion

Batch-wise comparison of cases and incidence of LRTI/ Pneumonia confirmed the outbreak. Further, there were no cases of Pneumonia amongst training staff (officers & sailors) and other civilian in adjoining areas. Consequent to increase in induction pattern at Naval Training Establishment, coupled with absence of accompanying increase. Consequently, analysis of living conditions established that overcrowding existed in dormitories, dining areas and all facilities related to training. Inadequate and improper ventilation, coupled with unsatisfactory knowledge of causative and propagating factors of Community Acquired Pneumonia (CAP) are determinant factors of the outbreak.

Recommendations

Administrative Measures: Aimed at reducing overcrowding and improving ventilation:

- Segregation of the recruits in groups
- Rectification of Exhaust fans and ceiling fans in various blocks to improve circulation of air
- Early procurement of adequate numbers of air circulators to improve ventilation in living areas and dining halls
- Re-arrangement/spacing out of double bunks in blocks, to enable a gap of at least 1.8 m with lockers on one side, in order to prevent air borne infections
- Staggering of meals (Lunch and dinner) with a gap of 45 minutes between 02 groups (blocks/ division)
- Expedient processing of works in Progress on High Priority, such as Provision of deficient single accommodation for trainees sailors with dining facilities (100 sailors), Provision of deficient single accommodation & dining hall for trainee sailors at Naval Training establishment and Provision of deficient single accommodation and dining hall for trainee sailors at Naval training Establishment (500 sailors). Once the project is completed, the old blocks would also be eased off by 900 men thus reducing overcrowding and ensuring the required air space and floor space for young recruits undergoing Military Training. Similarly 1400 users in new dining halls would decongest the old dining halls (600 non-veg + 300 veg + 300 non-veg = 1200 users). Thus, the total recruit strength of 2600 would be adjusted without overcrowding and suitable breaks together without staggering for 45 minutes

Medical Measures

Sensitization of all MOs and training teams to be more vigilant while examining recruits with respiratory tract infections. Early referral to the hospital for early detection

and prompt treatment of Lower Respiratory Tract Infection (LRTI).

Stepping up of Information, Education & Communication (IEC) Activities by Principal Medical Officer Training establishment & Indian Naval Hospital Ship to create awareness on personal hygiene, cough hygiene, hand washing and adequate hydration.

Meticulous and Religious conduct of Sanitary Rounds by Principal Medical Officer Training Establishment, with focus on aspects aimed at improving the hygiene conditions in living areas, dining halls, classrooms and the issue of ventilation/ air changes be stressed in the station. Observance of adherence to floor space, air space & distance between bunks be strictly monitored. Linen washing for recruits every week.

Notification of cases to competent authority as per Navy Orders (Group C disease).

Constitution of a Station Health Committee with Station Cdr, Senior Executive Medical Officer/Commanding Officer Naval Hospital, Works, Maintenance officers, Chairman, Garrison Engineer station as members and Principal Medical Officer Training Establishment as member secretary to jointly steer the health issues especially overcrowding until completion of new blocks. The committee needs to meet on a quarterly basis and submit report.

Chemoprophylaxis

Azithromycin or erythromycin prophylaxis may be resorted to as one of the preventive measures as the same has been found to be effective in reduction of pneumococcal carriage rates as well as reduction in pneumonia rates. Primary (i.e. tandem) prophylaxis can be administered to all recruits shortly after their arrival at a training facility/ Chilka or secondary (i.e. mass) prophylaxis is provided concurrently to all recruits in a given facility to interrupt established disease transmission. Therefore, Oral Azithromycin Chemoprophylaxis 250 mg two tablets 01 week apart in the induction week of upcoming batches is recommended.

Vaccination is not recommended at present as a preventive modality. Administration of polyvalent pneumonia vaccine to recruits may be considered after research on prevalent serotypes in our Military population and uniform policy on immunization for under trainees in all training establishment (Armed Forces) is made.

Conflict of Interest: None

References

1. Environmental Health Sciences -Chapter 44, Public Health & Preventive Medicine for the Indian Armed forces (Red Book), Armed Forces Medical College, Pune. 2008.
2. Levison EM. Disorders of respiratory system. Harrison's principles of Internal Medicine, McGraw Hill Companies Vol II, 15th Ed, 2003, pp.1476-81.
3. Ekdahl K, Ahlinder I, Hansson HB, Melander E, Mölsted S, Söderström M, Persson K. Duration of nasopharyngeal carriage of penicillin resistant Streptococci pneumoniae. Clin Infect Dis. 1997 Nov;25(5):1113-7. [PubMed] [Google Scholar]
4. World Health Organization. Rapid Health Assessment Protocols for Emergencies, WHO, Geneva 1999. [Google Scholar]
5. Nelson KE, Williams CM, Graham NMH, editors. Infectious Disease Epidemiology: Theory and Practice. Aspen Publishers, Inc., Maryland, 2001. pp.439-76.
6. Graham NMH, Douglas RM, Ryan P. Stress and acute respiratory infection. Am J Epidemiol. 1986 Sep;124(3):389-401. [PubMed] [Google Scholar]
7. Nelson KE, Williams CM, Graham NMH, editors. Infectious Disease Epidemiology: Theory and Practice. Aspen Publishers, Inc., Maryland, 2001. pp.439-76.
8. Bartlett JG, Breiman RF, Mandell LA, File TM Jr. Community acquired pneumonia in adults: guidelines for management. Clin Infect Dis. 1998 Apr;26(4):811-38. [PubMed] [Google Scholar]
9. Reimer LG, Carroll KC. Role of the microbiology laboratory in the diagnosis of lower respiratory tract infections. Clin Infect Dis. 1998 Mar;26:742-8. [PubMed] [Google Scholar]
10. Sanchez JL, Craig SC, Kolavic S, Hastings D, Alsip BJ, Gray GC, Hudspeth MK, Ryan MA. An outbreak of pneumococcal pneumonia among Military personnel at high risk: control by low doses post-exposure chemoprophylaxis. Mil Med. 2003 Jan;168(1):1-6. [PubMed] [Google Scholar]