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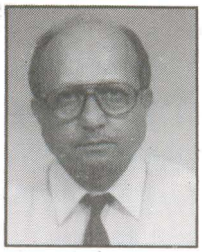

Prevention of Pulmonary Infection

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Although a great improvement has taken place in the outcome of pulmonary infections since the advent of antibiotic therapy, yet the mortality from pneumonias remains significantly high world over; and the situation may even get worse in the foreseeable future in view of the increasing ability of the microorganisms in gaining resistance to the antimicrobials that we are able and continuing to produce (1 - 4) ; and the rising incidence of pulmonary infections due to air pollution, overcrowding and undernutrition, the effect of population explosion, particularly in the developing countries. In these circumstances, it would be worth taking an approach towards the prevention of pulmonary infections.

Prevention of Pulmonary infections in the community

Social circumstances have important implications in the genesis of pulmonary infections. Overcrowding facilitates spread of infection through airbourne route. Coughing, sneezing and even simple talking may shower droplets laden with pathogens from respiratory tract; and any person in the proximity may inhale these pathogens floating in the air. These inhaled microorganisms at the initial stage remain confined to the anterior part of the nostril, before they move inwardly and downwardly to the nasopharynx, larynx, airways and the lung parenchyma. Therefore, a person should, as a social responsibility, cover his mouth and nose at the time of coughing and sneezing, and should not talk over someone's face; and everyone of us, as a precaution, should wash the anterior nares several times a day by drawing clean water into the nose and then blowing it out.

Any person attending large gathering of people, should particularly follow those instructions. People going for pilgrimage, should receive vaccination against respiratory pathogens available so far (to be discussed later on) specially those who are elderly, debilitated, having chronic cardiorespiratory diseases, diabetes mellitus and chronic illness, as they are more prone to contact respiratory infections.

Exposure to cold is known to be an aggravating factor in the development of pneumonias and other pulmonary infections. Probably, drop in environmental temperature somehow lowers local immunity (5). Inhalation of cold air might be damaging to the respiratory mucosa and mucociliary functions. In cold weather, mouth-breathing should be avoided because it deprives the breathed air of the warming facilities of the nasal cavity. Nasal cavity not only conditions the breathed air, but also humidifies it;

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and traps on its sticky mucous membrane the microorganisms and particulate materials present in the air when the air passes through the labyrinthine tortuous passage. Chronic nasal blockage due to deviated nasal septum, nasal polyp, adenoides etc. should, therefore, be cleared. Air polluted with gases like sulphur di-oxide, nitrous oxide and the acids it produces after mixing with rain water are also damaging to the respiratory tract (6, 7).

Adequate nutritional status is protective against respiratory infections. Global eradication of poverty is not practically possible, but in the developing countries mass education on food knowledge may make some impact in various ways in this respect. People should know that protein and calorie-rich food items like grains, lentils and legumes, potatoes and root vegetables should be grown in preference to the calorie-deprived food items like cabbage, cauliflower, cucumber etc. Fruit should be cultivated abundantly, and vitamin C rich citrus and other fruits ; vitamin A rich mangoes, papaya, carrot and other yellow-red pulp fruits should be freely consumed (8-10). Mother's milk is to be considered ideal for the infants and young children. These will have some protective effect against infection in general and respiratory infections in particular. Overeating and also obesity impose restriction on the respiratory pump (diaphragm) resulting in stasis in pulmonary secretion that invites infections.

Social behaviour plays an important role and smoking tobacco comes in the forefront. This increases secretion, causes oedema and impairs mucociliary clearance of the respiratory tract, all of these facilitate local infection (4). The mucociliary sticky blanket barrier which is constructed by the cilia of the ciliated columnar epithelium, and mucous secreted by the abundant mucous secreting cells in the airways upto the respiratory bronchioles ; and which is in constant motion unidirectionally towards the larynx, is very important in keeping the lower respiratory tract sterile ; and any interference in its function will facilitate infections in the lungs. Infection in the children rises due to passive smoking when parents smoke cigarettes indoors. Alcoholics frequently contract lower respiratory infections through various mechanism as malnutrition, vomiting and aspiration in stuporous state when cough reflex is inhibited. Lung abscess is a known complication of alcoholism. Other intoxicants like opium alkaloids, cannabis and cocaine that may compromise conscious state and cough reflex will precipitate lung infections. Intravenous drug abusers are liable to develop staphylococcal blood borne pneumonia. Sexual promiscuity will help colonisation of nasopharynx with various pathogens. H.I.V. infection which is acquired mainly through irresponsible sexual intercourse greatly increases the susceptibility of the lung tissue to the various infecting agents like Mycobacteria (avium-intracellulare) (11)., fungi (Pneumocystis carinii) and other micro organisms (12) (Table 1).

Table 1 Prevention of pulmonary infections in the community

1. Practise common hygienic measures, specially in large gatherinigs.
2. Avoid exposure to cold weather.
3. Avoid mouth breathing. Remove causes of chronic nasal blockage.
4. Ensure optimum nurtritional status and balanced diet. Mother's milk is preferrable for infants and young children.
5. Modify social behaviour and life-style. Do not smoke tobacco, drink alcohol, take addictive drugs, overeat and become obese, risk sexually transmitted disease (H.I.V.) by sexual irregularities.
6. Routine vaccination against pertussis, measles, Haemophilus influenzae type b. Selective vaccination against streptococcus pneumoniae and influenza virus.

Prevention of pulmonary Infections in the hospital

Load of pathogens is much higher inside the hospital environment i. e. air and the dust, as there is an aggregation of infected patients who are discharging large number of infecting agents through coughing, sneezing, talking, urine, faeces, infected skin wounds, sores and sinuses etc. Therefore, ill and debilitated patients present inside the hospital are exposed to greater risk of acquiring pulmonary infections.

In general, hospitals should have abundant natural ventilation and sunlight.Natural air current takes the pathogens away from the hospital, and ultraviolet light has bactericidal action.

Infectious patients should ideally be isolated in a single room and barrier nursed, specially those who are infected with dangerous pathogens like methicillin and multiresistant staphylococci, resistant strains of pneumococci and gram-negative bacilli. Health care workers must wash their hands with anitseptics each time they have attended these patients.

Gram-negative bacillary pneumonia is a serious problem in the intensive care units everywhere. The patients in these units are generally very ill; and for various reasons their nasopharynx becomes colonised by pathogens particularly gram-negative enteric bacilli. This colonisation is facilitated by stasis due to patient's inability of proper swallowing, use of contaminated catheter during suction; and regurgitation of enteric pathogens via gastric and oesophageal route. Neutralisation and suppression of acid in the stomach has been found to aggravate nasopharyngeal colonisation by the enteric pathogens. Sucralfate tablet or suspension 1 Gm 6 times daily as a substitute for commonly used H2-receptor antagonists or antacids shows a reduction in the frequency of nosocomial pneumonia (13). Keeping patients in semiupright position would also reduce the risk of aspiration (14). The infection from these nasophryngeal colonies spreads to the lungs by microaspirations, which are more likey to happen in the obtund semicomatosed intensive care unit patients with inhibited cough reflex; and also during endotracheal intubation. Meticulous aseptic precaution is necessary during suction, endotracheal intubation, airway humidification, ventilation and other invasive procedures.

Sedative drugs specially the ones that have depressant action on cough and respiration should be avoided. Antitussive drugs should not be used, unless the cough is too troublesome and dry. Coughing should be encouraged and stimulated. Cough is the main way by which the excessive secretion in the lungs is got rid of. Chest physiotherapy and squeezing the lungs by external pressure on the chest wall may drive some of the secretion to the proximal airway, from where it can be sucked out by a catheter in intubated patients, but it is in no way comparable with the clearing action of cough.

Comatosed patients need to be guarded adequately against aspiration. Oropharyngeal contents should be sucked frequently and aseptically. Feeding is to be done through nasogastric tube, taking special precaution that gastro-oesophageal sphincter incompetence created by insertion of the nasogastric tube does not aggravate the chance of aspiration. Prokinetic drugs and drugs that increase the tone of lower oesophageal sphincter such as metoclopramide, orally, intramuscularly or intravenously 10 mg 8 hourly or domperidone orally 10-20 mg every 4-8 hours and suppository 30 - 60 mg every 4-8 hours, or cisapride tablet and suspension 10 mg 3-4 times daily would help prevention of regurgitation and

aspiration. Erythromycin is also an effective prokinetic drug, but this should not be given together with cisapride as both prolong Q-T interval and their combination may induce serious ventricular arrhythmias. Comatosed patients with no cough and gag reflex should ideally be intubated for the prevention of aspiration.

Once the patient is intubated endotracheally and started on invasive artificial ventilation, the main objective will be to liberate the patient from the ventilator and extubate as soon as possible. Longer the patients remain intubated and ventilated, greater will be the risk of contracting pulmonary infection, and if the infection is already present, lesser will be the chance of its control. Continuous aspiration of subglottic secretion in patients receiving ventilation is effective in preventing aspiration pneumonia (15). The serious limitation of endotracheal intubation and invasive ventilation is that it abolishes the mechanism of cough and, therefore, the satisfactory clearing of the lungs of its secretions. Least the amount of sedatives and muscle-relaxants used, greater will be the chance of weaning off from the ventilator. If the patient needs too much of sedatives and muscle-relaxants for the smooth running of the ventilator, then perhaps the patient does not require the ventilatory support any more.

Post-operative, post-traumatic patients and patients after stroke, myocardial infarction and with serious illness and bed-ridden state are prone to develop pulmonary infections as well as pulmonary embolism/ infarction. Prevention of these complications is a priority in these patients. First, we have to know about the functions of diaphragm in this context.

Diaphragm is a unique rather fatigue-resistant muscle that is under voluntary as well as involuntary control. When it contracts well, it helps to open up the collapsed alveoli and small airways, particularly at the bases of lungs; and mobilises secretions and prevent stasis and consequent infection (16). Moreover, its contraction generates negative intrathoracic pressure, and higher is the strength of contraction, higher is the negative pressure inside the thorax. This negative pressure helps to pump blood from the subdiaphragmatic structures in the abdomen and lower limbs and also from the upper part of the body into the thoracic cavity. Also when the diaphragm moves down, it increases the positive intraabdominal pressure and imposes a squeeze on the portal circulation and inferior venacava ; and directs the blood in these venous systems due to the interposition of valves to one direction towards the thoracic cavity. Also on contraction diaphragm stretches open the opening through which inferior venacava enters the thorax. The resultant effect of all these events is the rush of blood into the right atrium during the contraction of the diaphragm. Stronger is the contraction of diaphragm, larger will be the amount of blood returning to the right atrium, then to the lungs. Therefore, diaphragm is not only a respiratory pump but also a circulatory pump clinically, we may appreciate the importance of this action of diaphragm by observing the accentuation of intensity of the onward flow dependent murmurs arising from the tricuspid and pulmonary valves during inspiration.

Stronger contraction of diaphragm brings larger amount of blood to the lungs, which means that the gas exchange becomes maximised, and also from the pulmonary infection point of view, more protective leucocytes and antibodies are brought to the lungs to help prevention and control of the infections in the lungs. Improved venous return to the right heart also clears venous stasis in the lower limbs and pelvis and reduces the chance of thromboembolism.

Therefore, in ill bed-ridden patients as mentioned above, diaphragmatic action has to be stimulated; and this will help prevent and control the lung infections as well as pulmonary embolism. Now, how to achieve it ?

Patients are to be encouraged to take frequent deep breaths. Five to ten minutes voluntary hyperventilation every hour when the patient is awake may be adequate. In between, he would preferrably hyperventilate also. Breathing exercises and incentive spirometer should be given to the patients to practise on (17-19). Besides instructing the patients on direct voluntary hyperbreathing, diaphragm may be made to work harder by indirect means. Early and fast walking and active movement of the lower limbs at ankles, knees and hip joints while the patients are in bed will increase the oxygen demand and breathing effort, and as a result the movement of the diaphragm. Coughing, yawning, sighing and sneezing cause diaphragm to contract forcefully, and therefore, would be of help. Painful conditions in the addomen and chest which splint the diaphragm, and restrict its movement (20), should be adequately controlled by analgesics. Analgesics like pethidine, pentazocine, paracetamol and analgesic anti-inflammatory drugs like ibuprofen, declofenace should be preferred. Morphine, codeine, dextroproproxyphene should be avoided, as besides their pain-relieving action they are also potent respiratory depressant i.e. diaphragmatic inactivator. For the same reason drugs that may cause drowsiness and respiratory suppression including many sedatives and even antihistaminics, should be avoided in these type of bed-ridden patients. Therefore, for the prevention and control of pulmonary infection in these ill, bed-bound patients the function of the diaphragm needs to be watched and augmented. For the prevention of pulmonary embolism/infarction, add to these meausres, the prophylactic conventional heparin subcutaneously 5000 to 8000 units 12 to 8 hourly or low-molecular-weight heparin 1 mg/kg body weight once daily (21, 22); and elastic stockings over the lower limbs (Table 2).

Table 2 : Prevention of pulmonary infections in the hospital

1. Hospitals should have adequate natural ventilation and light.
2. Patients infected with dangerous pathogens need to be isolated and barrier nursed.
3. Health workers should wash their hands in between patients.
4. Precautions to be taken in the intensive care unit:
   * Avoid acid suppression in the stomach.
   * Keep patients in semiupright position.
   * Practise meticulous asepsis during suction, endotracheal intubation, airway humidification, ventilation and any invasive procedure.
   * Avoid sedatives and cough suppressants.
   * Guard against aspiration in comatosed patients by using prokinetic drugs and endotracheal intubation. Aspirate continuously subglottic secretions in patients receiving ventilation.
   * Ensure early liberation from invasive ventilation and extubation.
5. Maximise diaphragmatic function by directly augmenting voluntary ventilation, and indirectly by early ambulation and exercise.

Modification of the specific conditions that facilitate pulmonary infections

Precautions are to be taken to prevent a permanent structural damage to the lungs, as it becomes the site of recurrent infections. Prompt and effective treatment of pneumonias, particularly bronchopneumonia in children; and also pulmonary tuberculosis is to be ensured. Early identification of the inorganic and organic dusts causing pneumoconiosis and allergic alveolitis respectively, should be made and exposure stopped.

Bronchiectatic lesions should be kept dry by regular postural drainage. Hiatus herina and achalasia cardia from where recurrent aspiration takes place should be

properly treated. Oral hygiene should be maintained, as aspiration of the oral contents where the oral and dental hygiene is poor, may lead to anaerobic infections of the lungs and lung abscesses, specially in diabetics. Infected paranasal sinuses need to be adequately treated with antibiotics and drained as its contents may be aspirated into the lungs. Tonsils and adenoides should not be removed on trivial reason, because they guard the gateway to the lower respiratory tract against infections.

Vaccination

Incorporation of pertussis and measles vaccines in the childhood vaccination programme, has greatly reduced the pulmonary complications of these infecions. Pertussis is included in the triple vaccine that is given as 3 doses each of 0.5 ml deep subcutaneoulsy or intramuscularly, at intervals of 4 weeks, the first dose at 2 months of age. Measles is included in MMR which is given in a single dose of 0.5 ml deep subcutaneously or intramuscularly at 12-15 months of age (23).

Haemophilus influenzae type b vaccine (Hib) is now being incorporated into the childhood vaccination schedule; and is administered as 3 doses, each of 0.5 ml deep subcutaneously or intramuscularly at 4 weeks intervals, starting at 2 months of age. In adults, it may be given to those at increased risk of invasive Haemophilus infuuenzae infection such as sickle cell disease, asplenic condition, and those receiving treatment for malignancy, and also chronic lung disease as chronic bronchitis, bronchiectasis etc. (23). It is highly effective in the prevention of Haemophilus meningitis in children (24); its impact on Haemphilus respiratory infection is yet to be assessed, but there is no reason why it would not confer protection against lung infection by this important respiratory pathogen (25).

A polyvalent pneumococcal vaccine provides satisfactory protection against pneumococcal infection. It is administered as a single dose of 0.5 ml subcutaneously or intramuscularly, to persons above 2 years of age, and for whom the risk of contracting pneumoccoccal pneumonia is high and dangerous, such as sickle cell disease, and asplenic or hyposplenic state, chronic cardiorespiratory diseases, chronic liver disease and cirrhosis, chronic renal disease and nephrotic syndrome, diabetes mellitus, immunodeficiency or immunosuppression due to disease or treatment including H. I. V. infection (23). It is available as 14-valent vaccine (pneumovax) and 23-valent vaccine (pneumovax 11). Revaccination with pneumovax may be given after 4 or more years, and with pneumovax 11 after 6 or more years, provided the first injection did not give rise to hypersensitivity reaction (23).

Influenza vaccine is given in the dose of 0.5 ml deep subcutaneously or intramuscularly in every autumn, to the high risk groups as mentioned under pneumococcal vaccination, and it confers significant protection to them against illness and death from influenza (26, 27). The strain of vaccine is chosen according to the recommendation by W. H. O. for that year.

Vaccination against staphylococci, legionella species, chlamydia pneumoniae, gram negative enteric bacilli as Klebsiella, Enterobacters, Pseudomonas, Serratia which may cause serious pneumonia is not possible yet, but may eventually be found. If ever an effective vaccine against staphylococcus, the most elusive pathogen, becomes a reality, it would be of great benefit. As our dependence on the antimicrobials will be increasingly uncertain, a strive towards finding vaccines against respiratory pathogens will be seriously undertaken.

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