

## Prevention of respiratory diseases

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### ABSTRACT

Chronic respiratory diseases are silent killers, neglected but leading cause of death. These diseases erode the health and well-being of the patients and have a negative impact on families and societies. Research on prevention and control of lung diseases is lagging behind and prevention and control programmes of respiratory diseases should be given high priority. This is because of the reason that respiratory diseases, perhaps more than any other types of diseases, are more easily prevented than cured.

**Key Words:** Prevention, respiratory diseases, bronchiectasis, pneumonia, asthma

### Introduction

Chronic respiratory diseases, such as asthma, chronic obstructive pulmonary disease (COPD), occupational lung diseases and lung cancer, kill more than four million people every year and affect hundreds of millions more. More than 500 million patients live in developing countries and 80 % of chronic disease deaths occur in deprived populations. <sup>[1]</sup> 300 million people have asthma, 80 million people have moderate to severe COPD while millions of others suffer from mild COPD, allergic rhinitis and often under diagnosed chronic respiratory diseases. Women and children are particularly vulnerable, especially those in low and middle income countries, where they are exposed on a daily basis to indoor air pollution from solid fuels for cooking and heating. In high income countries,

tobacco is the most important risk factor for chronic respiratory diseases.

Worldwide, chronic respiratory diseases account for 7% of all main causes of death and 4% of all main causes of loss of Disability Adjusted Life Years (DALYs). Everybody in this world is exposed to unhealthy air. About 2 million people are exposed to biomass fuel combustion, over 1 billion to outdoor air pollution, nearly 1 billion to tobacco smoke and infact nobody is devoid of allergen exposur. <sup>[2]</sup> Common chronic respiratory diseases as in International Classification of Diseases are asthma, bronchiectasis, COPD including bronchitis and emphysema, chronic rhinosinusitis, hypersensitivity pneumonitis, lung cancer, lung fibrosis, chronic pleural diseases, pneumoconiosis, pulmonary eosinophilia, pulmonary heart diseases

including pulmonary embolism and pulmonary hypertension, sarcoidosis and sleep apnea syndrome.

### **Asthma and Allergic disorders**

Asthma is a heterogeneous disease, usually characterized by chronic airway inflammation. It is defined by the history of respiratory symptoms such as wheeze, shortness of breath, chest tightness and cough that vary over time and intensity, together with variable expiratory airflow limitation.<sup>[3]</sup> Using a conservative definition, it is estimated that as many as 300 million people of all ages and all ethnic backgrounds suffer from asthma. It is estimated that there may be an additional 100 million people with asthma by 2025.<sup>[4]</sup> The development and phenotypic expression of atopic diseases depends on a complex interaction between genetic factors, environmental exposure to allergens and non-specific adjuvant factors, such as tobacco smoke, air pollution and infections. Preventive measures should address the general population, children at risk for development of atopic disease (high-risk infants), children with early symptoms of allergic disease or children with chronic disease.<sup>[5]</sup>

The pre- eminent risk factor for the development of asthma in childhood is the presence of allergy and a family history of atopic asthma or eczema. The sequential development of allergic disease manifestations during early childhood is often referred to as the “allergy march”. In the allergy march, atopic dermatitis and asthma are linked, but atopic dermatitis does not necessarily precede asthma, whereas allergic rhinitis is a risk factor

for asthma and can precede asthma.<sup>[6]</sup> Primary prevention may be aimed at the prevention of allergic sensitization or the prevention of asthma development in sensitized people. Other than preventing tobacco exposure both in utero and after birth, there are no proven and widely accepted interventions that can prevent the development of asthma. Pregnant women and parents of young children should be advised not to smoke.<sup>[7]</sup> The Hygiene hypothesis of asthma, has led to the suggestion that strategies to prevent allergic sensitization should focus on redirecting the immune response of infants towards a Th1, non allergic type response. Thus future trials of allergen avoidance must commence virtually at conception. Early childhood bacterial and viral infections may, however, also be associated with a reduced risk of developing atopic sensitization or allergic conditions, as the results of several recent studies suggest.<sup>[8]</sup>

An attempt should be made to induce a Th1 immunising response to allergen in immediate postnatal period. This might be achieved by high exposure to relevant allergens as distinct from the normal low dose exposure which is likely to occur with inhalants in the respiratory tract during the first months of life. Thus allergy and allergic diseases are less common in individuals who are tuberculin positive.<sup>[9]</sup> or have had measles rather than being immunised against measles.<sup>[10]</sup> However, the approaches proposed above are at present in the realms of speculation and much more needs to be learned about the mechanisms before embarking on any clinical studies.

There are some programmes reviewing interventions in children with established allergic disease but without asthma. This would appear to be very fruitful line of research. One study employing ketotifen, an antihistaminic which has very weak anti asthma properties was given to infants with atopic dermatitis and showed a reduced prevalence of asthma.<sup>[11]</sup> Another study has shown that cetirizine, an antihistaminic, which has an effect on eosinophilic trafficking, might prevent the development of asthma in individuals with atopic dermatitis.

The major emphasis to date has been on tertiary prevention of asthma, with goals to prevent exacerbations of asthma in those who already have the condition and to avoid deterioration in lung function or death from this chronic lung disease.

Environmental control measures to reduce exposure to indoor and outdoor allergens and air pollutants should be applied as much as possible to prevent asthma exacerbations and reduce the need for pharmacologic treatment. Asthma exacerbations may be caused by a variety of factors sometimes referred to as 'triggers', including allergens, viral infections, pollutants and drugs. Among the wide variety of allergen sources in human dwellings are domestic mites, furred animals, cockroaches and fungi. One study showed some efficacy of mattress encasing at reducing airway hyper responsiveness in children due to house dust mite.<sup>[12]</sup> The most important measure in controlling indoor air pollutants is to avoid active and passive smoking. Once asthma has occurred, treatment primarily involves removal

from exposure to the offending precipitant. The earlier the allergen avoidance is instituted after sensitization and the onset of disease, the greater the likelihood of success. Once the disease is well established with eosinophilic bronchitis, the less likely allergen avoidance, as a tertiary prophylaxis is likely to have any significant effect.<sup>[13]</sup> When all else measures fail in dealing with very severe food asthmatics, it would seem appropriate to consider dietary manipulations in an attempt to achieve improvement.<sup>[14]</sup> Some medications like aspirin and beta blockers can cause severe exacerbation in known asthmatics. So these should better be avoided in patients of bronchial asthma.

Leukotriene modifiers like montelukast have a small and variable bronchodilator effect, reduce symptoms including cough, improve lung function and reduce asthma exacerbations.<sup>[15]</sup>

Immunotherapy involves the administration of ever increasing doses of the allergen which is causing problems in an atopic individual in an attempt to induce some form of tolerance. Specific immunotherapy should be considered only after strict environmental avoidance and pharmacologic intervention have failed to control a patient's asthma.<sup>[16]</sup> However the treatment is not without hazards in that during the course of treatment, acute severe allergic reactions including anaphylaxis and death can occur.

### **Chronic Obstructive Pulmonary Disease**

Chronic obstructive pulmonary disease (COPD) is a heterogeneous disease with various clinical presentations. The basic

abnormality in all patients with COPD is airflow limitation. COPD is a major public health problem in subjects over 40 years of age and will remain a challenge for the future. COPD affects 210 million people worldwide. In India recent studies show a prevalence of respiratory symptoms in 6%–7% of non-smokers and up to 14% of smokers.<sup>[17]</sup> Reduction of total personal exposure to tobacco smoke, occupational dusts and chemicals, and indoor and outdoor air pollutants are important goals to prevent the onset and progression of COPD.

The two main strategies to prevent COPD due to tobacco smoke are smoking prevention and smoking cessation. Comprehensive tobacco control policies and programmes should target all ages, including young children, adolescents, young adults and pregnant women. Environmental Tobacco Smoke (ETS) is a term now widely used to refer to the combination of side – stream smoke that is released from the cigarette's burning end and mainstream smoke exhaled by the smoker. Education to reduce in utero risks for unborn children is of great importance to prevent the effects of maternal smoking in reducing lung growth and causing airways disease in early and later life. Smoking cessation is the single most effective and cost effective way to reduce the exposure to COPD risk factors. Quitting smoking can prevent or delay the development of airway limitation.<sup>[18]</sup> Firstly, the smoker should be thoroughly counselled for quitting smoking by telling him the adverse effects which he and his family can have. Counselling by physicians and other health professionals significantly

increases quit rates. Even a brief (3 minute) period of counselling to urge a smoker to quit results in smoking cessation rates of 5-10%.<sup>[19]</sup> Secondly, pharmacotherapy for smoking cessation is recommended when counselling is not sufficient or it fails. The most promising option is nicotine replacement therapy in the form of gum, inhaler, nasal spray, transdermal patch, sublingual tablet or lozenges. Nicotine replacement therapy is more effective when combined with counselling and behaviour therapy.<sup>[20]</sup> Antidepressants bupropion and nortriptyline have also shown promising results. Varenicline, a nicotinic acetylcholine receptor partial agonist has been demonstrated to be safe and efficacious.<sup>[21]</sup>

It is generally well accepted that there is a causal link between occupational dust exposure and the development of COPD. Many occupations have been shown to be associated with increased risk of developing COPD, particularly those that involve exposure to fumes and mineral and biological dusts. Prevention is central to the practice of occupation related COPD. There are two main strategies for prevention: primary prevention which entails removal or modification of the hazardous risk or exposure before the disease has occurred, and secondary prevention, early detection and prompt treatment when COPD has occurred. Primary prevention entails improving work practices such as engineering controls to reduce exposures. The best strategy for reducing inhalational exposures is to prevent or contain the exposure, or substitute a less harmful material for a

toxic one. Respiratory protection devices (respirators) are used to provide protection from toxic inhalation.

Reduction of exposure to smoke from biomass fuel, particularly among women and children is a crucial goal to reduce the prevalence of COPD worldwide. Controlling the health effects of indoor and outdoor air pollution requires strategies oriented toward populations and toward patients. Clinicians can make practical recommendations to their patients in order to reduce risk for disease and for exacerbation of established disease. If various solid fuels are used for cooking and heating, adequate ventilation should be encouraged.

### **Tuberculosis**

Tuberculosis (TB), an important preventable and treatable cause of death, is a major health problem worldwide. According to the recent estimates, there were 9 million new TB cases in 2013, 1.5 million people died of TB, including 3,60,000 patients co-infected with the human immunodeficiency virus (HIV). TB is slowly declining each year and it is estimated that 37 million lives were saved between 2000 and 2013 through effective diagnosis and treatment. [22]

The main reasons for the increasing burden of TB globally are poverty, neglect of the disease, collapse of health controlling and preventing TB are case finding and treatment with a view to prevent the spread of TB from smear positive cases. This includes standard short course directly observed chemotherapy recommended by World Health Organization. BCG vaccination and chemoprophylaxis also make

important contributions to the control of TB.

**Case finding** – Although mass radiography is not indicated as a case finding method in the population at large, there are clear indications for the screening of selected populations. Patients who have symptoms suggestive of TB should have their sputum examined for acid fast bacilli. Contacts should be screened by tuberculin testing and chest film. Skin test conversion merits chemoprophylaxis. Priority should be given to household and close family contacts of smear positive cases of pulmonary TB. [23] Other high risk groups are inhabitants of lodging houses, prisons, mental institutions and the homeless; immigrants and refugees; elderly in nursing homes; hospital employees including doctors, dentists, nurses and other healthcare workers working with patients. In the developing countries, where universal availability of radiography seems to be expensive, the most rewarding method of case finding is by direct smear examination of sputum from symptomatic cases.

Most countries recommend the use of BCG vaccination. BCG induced immunity develops about six weeks after the vaccination. The highest efficacy of BCG is observed for those forms of disease which involve hematogenous spread of bacilli such as tuberculous meningitis and disseminated tuberculosis. Various prospective studies on the clinical efficacy of BCG in preventing pulmonary TB have revealed level of protection varying from 0 to 76%. [24]

Chemoprophylaxis is the administration of chemotherapy to prevent the development of tuberculous disease. Primary chemoprophylaxis involves giving chemotherapy to individuals who have not so far been infected. Secondary chemoprophylaxis is chemotherapy for individuals with a positive tuberculin test who have been infected in an endeavour to prevent development of disease. The recommended dose of isoniazid for chemoprophylaxis is 300 mg daily for adults and 5 mg/kg upto a maximum of 300 mg in children. It has been suggested that infants born to sputum positive mothers should be given chemoprophylaxis for 6 months. Tuberculin skin test should be performed at the end of 6 months and if the infant is tuberculin negative, BCG vaccination should be administered.<sup>[25]</sup>

**Prevention of Multi Drug Resistant (MDR) and Extensively Drug Resistant (XDR) tuberculosis** – Government should have effective implementation of Revised National Tuberculosis Control Programme (RNTCP) for treatment of drug sensitive TB. Doctors should advise standard regimens in adequate dosages and for adequate duration and they should never add a single drug to the failing regimen. Patients should take the prescribed medication for adequate duration and should consult the doctor for any side effects before leaving the treatment themselves.

### **Pneumonia**

Community Acquired Pneumonia (CAP) is defined as lower respiratory tract infection in a non-hospitalized person that is associated with symptoms of

acute infection with or without new infiltrate on chest radiographs.<sup>[26]</sup> It is the 7<sup>th</sup> leading cause of death in United States with about 5.6 million cases annually.<sup>[27]</sup> 80% of CAP patients are treated outside hospital, 18% in the medical ward and remaining 2% in the intensive care unit. Hospital Acquired Pneumonia (HAP) is defined as pneumonia that occurs 48 hours or more after admission, which was not incubating at the time of admission. Ventilator Associated Pneumonia (VAP) refers to pneumonia that arises more than 48–72 hours after endotracheal intubation. Health Care Associated Pneumonia (HCAP) includes any patient who was hospitalized in an acute care hospital for two or more days within 90 days of the infection; resided in a nursing home or long-term care facility; received recent intravenous antibiotic therapy, chemotherapy, or wound care within the past 30 days of the current infection; or attended a hospital or hemodialysis clinic.<sup>[28]</sup>

**Community acquired pneumonia**<sup>[26]</sup> - Vaccines targeting pneumococcal disease and influenza remain the mainstay for preventing CAP. All persons >55 years of age, household contacts of high risk persons, persons having associated comorbid conditions like chronic cardiovascular and pulmonary diseases including asthma, chronic renal failure, immunocompromised states and health care professionals should receive inactivated influenza vaccine. Revaccination is required yearly. Pneumococcal polysaccharide vaccine is given to all persons of >65 years, current smokers and persons having

associated diabetes mellitus, asplenia or other immunocompromised states. Revaccination is done after 5 years. Cases of pneumonia that are of public health concern and which can spread very rapidly in an epidemic form should be reported immediately to the state or local health department so that early measures could be taken to prevent others. Respiratory hygiene measures, including the use of hand hygiene and masks or tissues for patients with cough, should be used in outpatient settings and emergency departments as a means to reduce the spread of respiratory infections.

**Hospital acquired pneumonia (HAP)<sup>[28]</sup> –**

The most important measure to prevent HAP is effective hygiene to be maintained by health care professionals. Regarding ventilator associated pneumonia (VAP), noninvasive ventilation should be preferred over mechanical ventilation requiring intubation and being a potential source of further infection. Patients should be kept in semi recumbent position rather than supine position to prevent the chances of aspiration. Whenever possible, enteral nutrition is preferred over parenteral nutrition because of the risk of infection due to indwelling intravenous catheters. Oral hygiene should be maintained with chlorhexidine and sucralfate or H<sub>2</sub> receptor blockers should be given to prevent stress bleeding causing intubation pneumonia. Intensive insulin therapy is recommended to maintain serum glucose levels between 80 and 110 mg/dl in ICU patients to reduce nosocomial blood stream infections.

**Pulmonary Carcinoma**

Pulmonary carcinoma is the most frequently diagnosed major cancer in the world and the most common cause of cancer related death in both men and women worldwide.<sup>[29]</sup> Out of the total, 51% of the cases occur in developed countries and 75% occur in men. Lung cancer accounts for 6.8% of all malignancies in India. Central to the prevention of lung cancer is the concept that carcinogenesis is not an event but a process, a series of discrete cellular changes that result in progressively more autonomous cellular processes. Primary prevention concerns the identification and manipulation of the genetic, biologic and environmental factors in the causal pathway. Smoking cessation and chemoprevention are primary prevention activities. Secondary prevention concerns the identification of asymptomatic neoplastic lesions combined with effective therapy. Screening is a form of secondary prevention.

Tobacco use through cigarettes and other means is the most avoidable risk factor for lung cancer. Lung cancer mortality rates correlate with the number of cigarettes smoked per day as well as the degree of inhalation of cigarette smoke. The duration of smoking also appears to be important that there is evidence that smoking one pack per day for 40 years is associated with a greater risk than smoking two packs per day for 20 years. It has also been established that stopping the habit or appreciably reducing the number of cigarettes smoked results in a decreased risk of developing pulmonary carcinoma.<sup>[30]</sup>

Chemoprevention<sup>[31]</sup> of lung cancer is a relatively new concept. It involves the use of specific natural or synthetic chemical agents to reverse, suppress or prevent carcinogenesis before the development of invasive malignancy. Several large scale trials have been done to find the role of alpha tocopherol and beta carotene in preventing lung cancer. It was found that beta carotene increases the risk of lung cancer while alpha tocopherol has protective effect.

**Screening** – The ultimate goal of improving long-term survival in lung cancer will be achieved only when cancer can be detected in its early stages and lesions can be localized in large numbers.<sup>[32]</sup> Earlier there were only two procedures capable of detecting presymptomatic, early stage lung cancer. These were the chest radiograph and sputum cytology for malignant cells. Sputum cytology examination has been shown in several studies to lead to detection of lung cancer at an earlier stage, resulting in an improved 5-year survival rate. Monoclonal antibody detection, fluorescence bronchoscopy, and low-dose spiral CT increase diagnostic sensitivity and improve the ability to localize early-stage lesions.<sup>[33]</sup> Utilizing these new techniques and improving the definition of high-risk groups may improve the success and cost-effectiveness of early detection based on sputum cytology. But screening for early stage lung cancer is less attractive, more expensive and appears to have less potential for reducing mortality than primary prevention.

#### **Bronchiectasis**

Bronchiectasis is increasingly recognized as a major cause of respiratory

morbidity especially in developing countries. Even in affluent countries, bronchiectasis is increasingly seen in some community subsections and occurs as a comorbidity and disease modifier in respiratory diseases such as chronic obstructive pulmonary disease (COPD). Although such improvements in health are sometimes taken for granted in western society, this is not the case in many developing countries where bronchiectasis remains a common problem.<sup>[34]</sup> The main preventive measure includes medical treatment by antibiotics, bronchodilators, and physical therapy to promote drainage of secretions. While others are immunizations against measles and whooping cough, improved living conditions and nutrition.

Primary prevention deals with the prevention of bronchiectasis to occur in an individual. Early identification and treatment of conditions that tend to cause bronchiectasis may prevent the development of bronchiectasis or reduce its severity. As recurrent childhood pneumonias and tuberculosis are the major infectious causes of bronchiectasis, an effort should be made to treat these conditions as early and effectively as possible so that these conditions could not lead to bronchiectasis. The marked decline in the prevalence of bronchiectasis after the introduction of antibiotics is a consequence of the more effective treatment of childhood respiratory infections, including pneumonia. Other important factors have been the introduction of effective vaccination programmes for whooping cough and measles, the decline in prevalence of

pulmonary tuberculosis and better social conditions. Effective treatment of tuberculosis under Revised National Tuberculosis Control Programme (RNTCP) can lead to significant decline in the incidence of bronchiectasis.

The main role of secondary prevention deals with the prevention of complications of bronchiectasis to occur like infective exacerbations, hemoptysis, sinusitis, amyloidosis, atelectasis, pneumonia, empyema, pneumothorax and bronchopleural fistula.

The goals of therapy are to improve symptoms, to reduce complications, to control exacerbations, and to reduce morbidity and mortality. Antibiotics and chest physiotherapy are the mainstay modalities. Oral, parenteral, and aerosolized antibiotics are used, depending on the clinical situation. In acute exacerbation, broad-spectrum antibacterial agents are preferred. Acceptable choices for the outpatient who is mild to moderately ill include amoxicillin; tetracycline; trimethoprim-sulfamethoxazole; a newer macrolide, such as azithromycin; <sup>[35]</sup> a second-generation cephalosporin; or one of the quinolones. In general, the duration is 7-10 days. Other modalities may include bronchodilators, corticosteroid therapy, dietary supplementation and oxygen.

Surgery is an important adjunct to therapy in some patients with advanced or complicated disease. In general, surgery should be reserved for patients who have focal disease that is poorly controlled by antibiotics. The involved bronchiectatic sites should be completely resected for optimal symptom control. Other indications for surgical intervention are recurrent acute

infective episodes, excessive sputum production, massive hemoptysis and foreign body or tumor removal.

**Chest physiotherapy**<sup>[36]</sup> - Bronchiectasis is a chronic and hypersecretive disease with retention of secretion that causes alterations to pulmonary ventilation making bronchial hygiene essential. The respiratory physiotherapeutic treatment makes conventional clearance techniques, such as postural drainage and percussion, available. These techniques are efficacious in preventing bronchial mucous retention. Standard chest physical therapy with postural drainage, cough, and the forced expiratory technique is the cornerstone of such treatment regimen. Postural drainage with percussion and vibration is used to loosen and mobilize secretions. Other devices available to assist with mucous clearance include flutter devices, intrapulmonic percussive ventilation devices, and incentive spirometry. Newer modalities, such as mechanical chest percussion and mask positive airway pressure, warrant further clinical trials before they can be used routinely.

**Pulmonary rehabilitation**<sup>[37]</sup> - The 3 major breathing techniques include the following:

Pursed lip breathing - Patients exhale slowly for 4-6 seconds through pursed lips held in a whistling position. This technique relieves dyspnea by increasing expiratory airway pressure, thereby inhibiting dynamic expiratory airway collapse.

Posture techniques - Leaning forward postures frequently relieve dyspnea in patients by reducing respiratory effort.

The shifting of abdominal contents elevates the depressed diaphragm cranially, resulting in improved performance.

Diaphragmatic breathing - The patient is taught to employ only the diaphragm during inspiration and to maximize abdominal protrusion. Not all patients benefit from this technique; therefore, close clinical monitoring to ascertain efficacy is required.

### **Role of pneumococcal and influenza vaccines<sup>[38]</sup>**

- Role of Pneumococcal and Influenza vaccines should not be underestimated.

Conjugate pneumococcal vaccine is part of the routine infant immunisation schedule in many countries.

Current recommendations for additional pneumococcal vaccination include children and adults with chronic suppurative disease.<sup>[39]</sup>

Current recommendations for inactivated influenza vaccination includes adults aged 65 years and over, those in residential care and health care workers and also all adults and children with chronic illness, particularly cardiac and pulmonary diseases.

### **Conclusion**

All said and done, prevention is better than cure applies in all diseases and its more important in respiratory diseases where some diseases can not be cured but only treated. A lot more research and public awareness about the prevention of respiratory diseases is the need of the hour.

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