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RESEARCH ARTICLE

Tuberculosis Elimination: Importance of Environmental Control and Creation of Carbon Neutral Hospitals and Sanatoriums

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SUMMARY

Tuberculosis is planned to be eliminated by 2035 using the end TB strategy by WHO. The strategy has moved on from the concept of TB control using microbiological methods of detection and therapy towards elimination strategies by addressing the social determinants of Tuberculosis. One such area of focus is environmental control and preventing the airborne spread of infection. The importance of environmental engineering and the creation of Carbon neutral hospitals as part of the Tuberculosis elimination strategy is discussed.

Keywords: Tuberculosis, Elimination, environment, carbon neutral

Introduction

As we march towards WHO's ambitious goal of Tuberculosis elimination by 2035 and introspect into the data from the field, where lives are still lost due to Tuberculosis (TB) and the disease ravages on, one is wary of the Sisyphean task that lies before us. Globally 6 million people lost their life due to Tuberculosis in 2021¹

WHO adopted the End TB strategy in 2014 with a bold vision of "A world free of Tuberculosis, zero deaths, disease and suffering due to TB" with the goal of ending the world TB epidemic. The main targets are a 95 % reduction in TB deaths in 2035, a 90 % reduction in TB incidence rates compared to 2015, and zero families having catastrophic costs due to TB by 2035².

There has been a paradigm shift from TB control to TB elimination.

TB control is a strategy aimed at cutting down the transmission of disease through early diagnosis and treatment, in order to break the chain of transmission. TB elimination strategy widens the control strategy by identifying and treating latent TB cases from where future cases are generated thereby preventing the emergence of new cases³

TB elimination, defined as less than one TB case per million population, is a scenario where the prevalence is so low that it ceases to be a public health problem³.

According to WHO³, the current rate of decline of TB is 1.5 % per year. Optimizing the use of current and new tools, and pursuing universal health care and social protection measures can lead to about a 5 % decline in prevalence per year. To achieve the targets of TB elimination by 2035, newer tools including vaccines, newer prophylaxis and treatment regimens and point-of-care testing will be required to achieve the decline of 17% needed to meet the targets.

Most of our efforts to TB elimination now focus on earlier diagnosis and treatment and slowly is widening towards TB elimination by treatment of Latent TB infection, this being the pool from where future disease cases are generated⁴. Probably now is the time to also turn focus on halting the transmission of Tuberculosis and focusing on environmental factors like overcrowding and rapid urbanization which are also social drivers of the pandemic.

India's National Strategic plan (2017 -25) for ending TB has framed appropriate strategies under four pillars based on the foundations of "universal coverage" and "social protection"

"Prevent – Detect – Treat – Build "

Preventive strategies for treatment of Latent TB infection have been introduced in National TB Elimination Programs. Focus on earlier diagnosis using molecular diagnostics like Xpert Mtb/XDR, TRUNAT, next generation sequencing are being introduced. Drug resistant TB (DRTB) treatment guidelines have been updated and focus is on all oral shorter DRTB regimen wherever feasible³.

Preventive strategies need to also focus on Primordial prevention that is the emergence of risk factors most of which are social and Environmental.

Social determinants of Tuberculosis

Social determinants of health are those conditions that generate or reinforce social stratification in society leading to psychosocioeconomic inequities which adversely affect the health of an individual. In TB, these social determinants including malnutrition, educational disparities, overcrowding and financial, cultural and geographic barriers in access to health care. In turn these influence the 4 stages of TB pathogenesis: exposure to infection, progression to disease, late or inappropriate diagnosis and treatment and poor treatment adherence and success⁵.

One practical approach to the problem of creating a plan for addressing the social determinants of TB is the model envisioned by Brian C. Castrucci & John Auerbach⁶.

Broadly the social determinants can be classified as downstream (providing clinical care), midstream (addressing individual's social needs) and upstream (improve community conditions) determinants⁶

Currently, the National Tuberculosis elimination program (NTEP) of India has its focuses on the downstream and midstream determinants and is addressing these through various measures like earlier treatment diagnosis and appropriate treatment, Nikshay poshan yojana, TB free workplace campaign, TB champions, integration with other programs like HIV and DM⁷.

There is a felt need to address the upstream determinants of disease by improving community conditions of which environment control like proper urban planning, preventing overcrowding and restoration of the green cover of urban areas too play a vital role in preventing the transmission of airborne infections.

Dr. David Muthu's view on Tuberculosis as a social disease

In his book "Pulmonary Tuberculosis, its etiology and treatment published first in 1921, Dr. David Chowry Muthu, the founder of Thambaram sanatorium (currently known as Government Hospital of Thoracic medicine – GHTM) , Chennai, India said "Cause of tuberculosis is not the tubercle bacillus but that the state of the patient is brought about by various social and economic conditions, by want of fresh air, natural surroundings, sufficient food, by the overwork and worry produced chiefly by the industrial system...." ⁸

The best solution regarding the upstream determinants of Tuberculosis are those envisaged by Dr. David Chowry Muthu in 1921 ⁸

- Stop all wars and war expenditure, reduce armaments, and promote peace
- Reduce taxation, free imports, and exports, cheapen the necessities of life
- Encourage industry, promote agriculture and small holdings, so that people can live on fresh foods, carry out land reform and land development
- Help to multiply garden cities and garden suburbs, clear slums and build houses

Dubois' lecture on human and environmental determinants of Tuberculosis

Jean Dubois whose book "The white plague. Tuberculosis, man and the society" was first published in 1952, debated that the discovery of TB bacilli led us away from the concept of inherent susceptibility. Dubois stressed in his book that it was imperative to investigate the human and environmental factors that determine resistance to infection and suggested two ways to attack the progression of the disease, decreasing risk of infection and boosting resistance. ⁹

Dubois effectively argued that throughout the 20th century, even before the introduction of effective chemotherapy, TB incidence declined steadily in most industrialized countries, although it did increase temporarily during the two world wars. The reasons for this decline in TB incidence were period of economic growth, social reform, poverty reduction and improved living conditions as well as important advances in medicine and public health⁶

Work of Wells and Riley on airborne infection control ¹⁰

In the present context, one is reminded of the work done by William F Wells who in the 1930s introduced the droplet nuclei hypothesis and spent the remaining 30 years of his life gaining insight into the process of air borne infections. In the 1950s, Riley unequivocally established the airborne spread of Tuberculosis. Their work led to the concept that airborne infections could be controlled by three ways : vaccination, therapeutic medication and environmental controls. The mathematical model developed formed the basis of engineering and environmental measures in preventing airborne spread of infections. It was observed that every doubling of the ventilation halves the chance of getting infected.

Airborne infection control ¹¹

Central TB division of Government of India has framed guidelines on airborne infection control in healthcare and other settings. The document defines one air change has occurred when volume of air entering or exiting a room is equal to the volume of the room. The proportion of airborne particles eliminated with each air change is 63 % under ideal conditions of mixing. A second air change removes 63 % of what remains and so on. Subsequent increases with each air change leads to an exponential decrease in droplet nuclei.

The guidelines speak about a combination of administrative, environmental and personal protection controls needed to prevent airborne infection control based on local epidemiological, socioeconomic, and climatic factors.

Administrative controls include fast tracking of patients with respiratory infections like the one adapted in India's national AIDS control program using the 4s screening for TB which may also work for other airborne infections.

Personal protection equipments like PPE and N95 that have become popular during the covid pandemic may work in TB wards and during aerosol generating procedures like nebulisation and bronchoscopy.

Stress on environmental controls is emphasised based on local factors and resources. Natural ventilation may be the best way possible and may be aided by mechanical devices properly designed, placed and maintained. Ultraviolet germicidal devices are considered as complementary tools.

Carbon neutral campus and its importance in TB elimination

Carbon footprint refers to the amount of greenhouse gases emitted due to various human activities. Greenhouse gases (GHGs) are gases that increase the temperature of the Earth due to their absorption of infrared radiation thereby adversely affecting the climate creating droughts and floods where its least expected. Although some emissions are natural, the rate at which they are being produced has increased because of human activities. These gases are emitted from fossil fuel usage in electricity, heat, and transportation, as well as being emitted as by-products of land clearance and the production and consumption of food, manufactured goods, materials, wood, roads, buildings, transportation, and other services.

The most common GHGs are carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), and many fluorinated gases like hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride, and nitrogen trifluoride. There are several ways to reduce one's greenhouse gas footprint, choosing more energy-efficient eating habits, using more energy-efficient household appliances, increasing the usage of fuel-efficient cars, and saving electricity.

India is the third-largest emitter of greenhouse gases and accounts for 2.46 billion metric tonnes of carbon or 6.8% of the total global emissions. The average carbon footprint of every person in India was estimated at **0.56 tonnes per year**— with 0.19 tonnes per capita among the poor and 1.32 tonnes among the rich.

Sustainable development goal 13 calls for action to combat climate change and its impact. Action is now needed to limit global heating to 1.5 °C preindustrial levels (currently we are heading towards 3.2° C) which needs carbon emissions to be halved by 2030 and zero by 2050. Furthermore, the emission of other greenhouse gases needs to be reduced to zero between 2050 to 2070.

The health care activities of diagnosis and treating a disease contribute to 4 to 6 % of global emissions according to available data ¹². Hence it makes more sense to prevent a disease than to diagnose and treat one and efforts should be directed towards the same.

Vision of carbon neutral Government Hospital of Thoracic Medicine, Chennai

Government hospital of Thoracic medicine, Chennai, India is one of the centres of excellence for TB care in India. This hospital is striving to develop plans to improve energy efficiency, restore natural biodiversity, build greener business relations, and create a Carbon neutral campus that monitors environmental impacts.

The founding fathers of GHTM in all their wisdom selected this site at the foothills of Pachamalai hills for its strategic location and its ventilation long before the era of chemotherapy for Tuberculosis. The wards were designed with adequate natural and cross ventilation and spaced out with 33 wards spread over 74 acres and till today this design is probably what has prevented an outbreak of airborne infections in the public visiting this campus and health personnel involved in the care of patients for nearly a century since 1928.

The role played by the flora of the campus should be emphasized. Trees play a vital role in the elimination of greenhouse gases, reducing pollution, improving air quality, and improving Oxygen levels all of which are vital for patients with lung ailments and play a restorative role in the health of the individual affected. One area the hospital is focusing on is afforestation, a small but decisive step towards which was taken in celebrating 75 years of India's independence by planting 750 trees in the campus recently.

Perhaps the time has come to restart such sanatorium for at least the severely ill TB patients and DRTB patients so that a holistic approach towards treatment beyond just chemotherapy can be adopted

As Wayne Fields said in his nursery rhyme, "*The best six doctors anywhere and no one can deny it, are sunshine, water, rest and air, exercise and diet. These six will gladly you attend if only you are willing, your mind they'll ease, your will they'll mend, and charge you not a shilling*".

References

1. Global Tuberculosis Report 2022. www.who.int/teams/global-tuberculosis-programme/tb-reports/global-tuberculosis-report-2022. Accessed March 19, 2023. <https://reliefweb.int/report/world/global-tuberculosis-report-2022>
2. Matteelli A, Rendon A, Tiberi S, Al-Abri S, Voniatis C, Carvalho ACC, Centis R, D'Ambrosio L, Visca D, Spanevello A, Battista Migliori G. Tuberculosis elimination: where are we now? *Eur Respir Rev*. 2018 Jun 13; 27(148):180035.
3. World Health Organization. Implementing the end TB strategy: the essentials. Geneva: WHO;2015. Accessed May 13, 2023 <https://www.afro.who.int/publications/implementing-end-tb-strategy-essentials> on 13052022
4. WHO consolidated guidelines on tuberculosis: tb preventive therapy. Accessed on March 19, 2023. <https://apps.who.int/iris/bitstream/handle/10665/331170/9789240001503-eng.pdf>
5. Hargreaves JR, Boccia D, Evans CA, Adato M, Petticrew M, Porter JD. The social determinants of tuberculosis: from evidence to action. *Am J Public Health*. 2011 Apr;101(4):654-62..
6. Castrucci B, Auerbach J. Meeting Individual Needs Falls Short of Addressing Social Determinants of Health. *Health Affairs Blog*. January 16, 2019. Accessed May 13, 2022 <https://debeaumont.org/news/2019/meeting-individual-social-needs-falls-short-of-addressing-social-determinants-of-health>
7. Operational guidelines for TB services at Ayushman Bharat Health and wellness centres. Accessed on March 19, 2023 <https://tbcindia.gov.in/showfile.php?lid=3575>
8. David C Muthu .Pulmonary tuberculosis, its etiology and treatment: a record of twenty-seven years' observation and work in open-air sanatoria. London, published by Baillière, Tindall & Cox; 2nd edition, January 1, 1927
9. Dubos J, Rosenkrantz BG, Mechanic D. The white plague, Tuberculosis, man and the society. New Jersey Rutgers University Press March 1 1987.
10. RL Riley. Indoor airborne infection. *Environmental international* 1982(8); 317 – 320
11. Guidelines on airborne infection control. Accessed on March 19, 2023. <https://tbcindia.gov.in/index1.php?lang=1&level=1&sublinkid=4519&lid=3015>
12. Harries AD, Martinez L, Chakaya JM. Tackling climate change: measuring the carbon footprint of preventing diagnosing and treating TB. *Public Health Action* 2021; 11(1): 40