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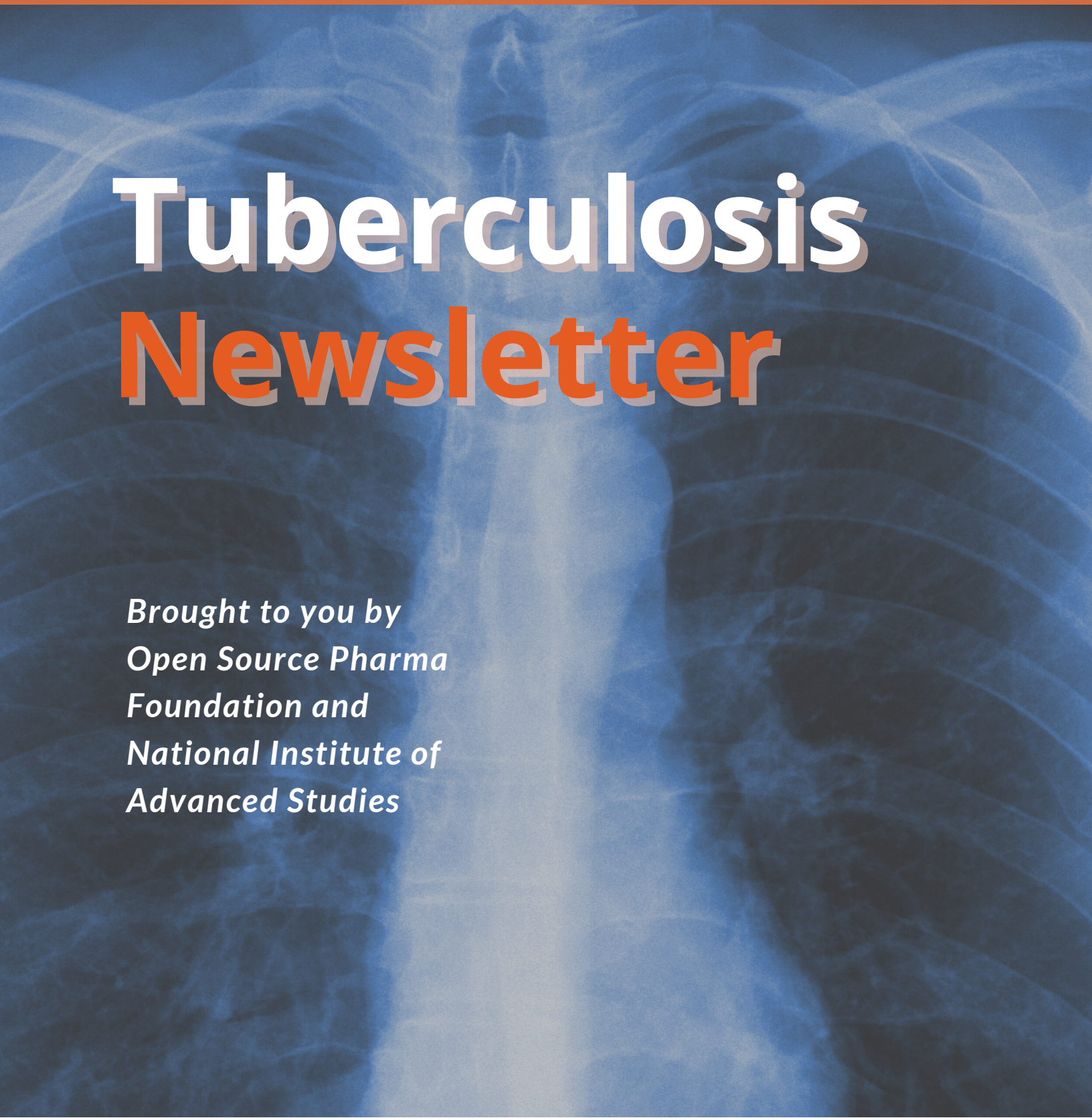

Tuberculosis Newsletter

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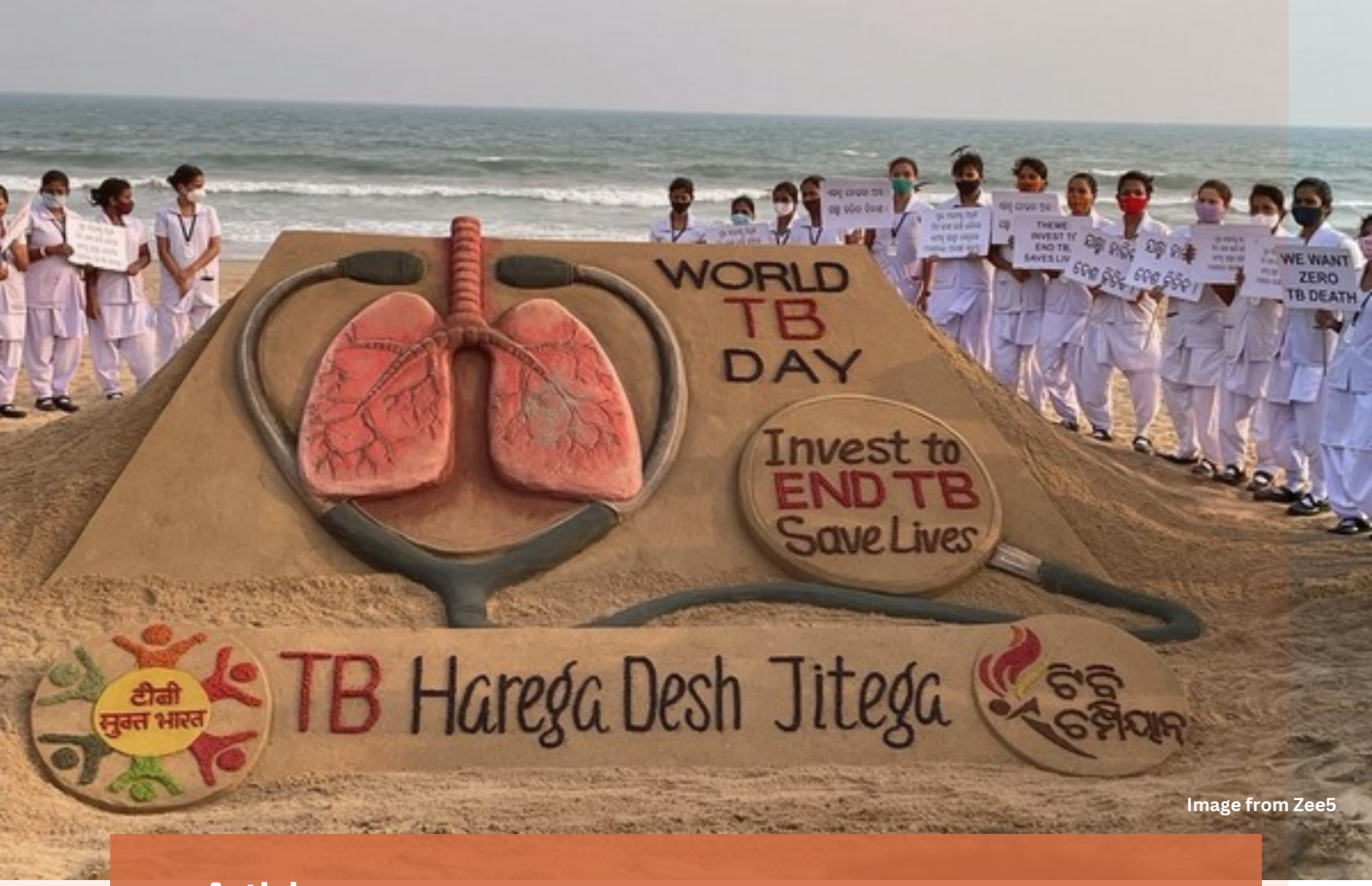

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Articles

Yes! We can END TB

Dr. Nibedita Rath, Scientific Director,
Open Source Pharma Foundation,
Bengaluru, India

This year's World TB Day theme: Yes! We Can End TB serves to remind us that we can and must do more to end TB. Different stakeholders, governments, civil society, and the private sector are collectively committed to ending the global TB epidemic by 2030.

To achieve the goal, all partners should collaborate to strengthen the existing diagnostic and treatment facility, patient support system and communication that needs to be built around the strategy. The concurrent multi-prong approach will lead to the achievement of the goals. All stakeholders must actively participate in the TB elimination program to augment their efforts in this direction to make this dream a reality. Synergies must be developed among partners, and there should be no duplication of efforts.

India's fight against TB started much before the government of India launched a National Tuberculosis Control Program in 1962. The article by Prof Mridula Ramanna talks about the Anti-TB League that was formed in India in 1912. The Anti-Tuberculosis League (ATL) was created in 1912 in Bombay, India, with the aim of educating people about Tuberculosis and preventing its spread. The ATL was a public-private partnership with representatives from the government, the medical community, and private citizens. The ATL was successful in raising money to fund its activities and in educating the public about Tuberculosis. Indian doctors endorsed the ATL and its work.

Tuberculosis is a deadly disease that has been around for centuries. It is caused by a bacterium called Mycobacterium tuberculosis and can affect any part of the body. While it is often thought of as a disease of the past, Tuberculosis is still a major global health problem, causing over 1.5 million deaths each year. In this article, the myths and reality of Tuberculosis are explored.

The article by Dr. Rudrodip Majumdar discusses the negative effects of overcrowding on tuberculosis rates. Tuberculosis is a deadly disease that is most commonly found in developing countries with poor living conditions. The article discusses how the lack of living space and poor hygiene conditions in these areas lead to an increase in tuberculosis rates. The article also discusses how the lack of living space and poor hygiene conditions in these areas lead to an increase in other diseases, such as respiratory infections. Finally, the article provides a number of solutions that could be implemented in order to help reduce the tuberculosis rates in these areas.

Data Science is a rapidly growing field that uses data to create information, meaning, interpretation, knowledge, action, feedback, and learning. The article by Prof Arkalgud Ramaprasad has emphasized how the use of data science helps transform the tuberculosis care system in India by integrating it with the other platforms that are currently used to address the problem of TB. This can help improve the effectiveness of TB care by assuring timely, coordinated, and scheduled care. Data Science can also be used to target sensitization and prevention measures to individuals, families, communities, and the public based on their biological, medical, social, and economic risk profiles.

Recurrent Tuberculosis constitutes 5-30% of the global TB burden, with a higher proportion found in high-prevalence settings. Recurrence may be due to endogenous relapse or exogenous reinfection.

The article by Dr. Naresh Shetty talks about a woman's journey who had recurrent Tuberculosis. She has had to undergo treatment multiple times for the disease. The article discusses the difficulties in identifying recurrence in routinely collected data and the challenge this poses.

The article by Dr M Sai Baba reflects upon the need for more investment and involvement to eradicate the disease. He emphasizes the need to create more awareness and resources, and opportunities to help those affected by the disease. He emphasized investment from the public and private sectors in order to provide better access to healthcare and improved economic opportunities for people living with the disease. Dr. Arora has explored the myths and realities surrounding tuberculosis.

We can contribute to the Pradhan Mantri TB-Mukt Bharat Abhiyaan. Encouraged by PM Modi's mantra of Sabka Saath, Sabka Vikas, Sabka Vishwas Aur Sabka Prayas, each one of us can come together and join the Jan Andolan to make India TB-free by 2025.

Anti-Tuberculosis League in Bombay City, 1912

Prof. Mridula Ramanna, Former Head Department of History, SIES College of Arts, Science & Commerce, Mumbai, India

Robert Koch's announcement of the tubercle bacillus in 1882 was a landmark, but attention in colonial India moved from the bacillus to the conditions in which it spread. From the turn of the century, tuberculosis was viewed as 'a malady of civilization,' caused by overcrowding and stress associated with urban industrialized life. Tuberculosis was euphemistically referred to as cough and or fever. It was not high on the medical agenda of British India, unlike cholera or malaria, as it did not directly affect the economy or administration [1]. Yet, in Bombay city, tuberculosis came to be recognized as a public health challenge, and it was Sir Ratan J. Tata who suggested the project of the Anti -Tuberculosis League (ATL) at a public meeting in 1912 and promised an annual donation of Rs. 15,000, for ten years. The ATL was an example of a public private partnership. A representative general committee consisting of one hundred and sixty prominent citizens, with J.A. Turner, Health Officer and N.H. Choksy, Superintendent, Arthur Road (AR)infectious diseases hospital as secretaries, and an executive committee, comprising of philanthropists, doctors, the Municipal Commissioner, and the Surgeon General, were appointed. The aims of the ATL were to spread information about tuberculosis through lectures and pamphlets, conduct visits and medical inspections at schools, mills, docks, and factories, to supervise milk and food supplies, and to create 'a special fund, to relieve distress.' Life members and annual members were enrolled into the ATL. A collection of Rs.1,35,000 was made. Donations came from the Western India Turf Club, the Grain Merchants' Association, Tata Sons, David Sassoon, doctors and anonymous donors, who signed as a 'Parsi' and 'a patient.' The Tata Mills, Sir Shapoorji Broacha, Sir Cowasji Jehangir and Narottam Morarji Goculdas promised to contribute, at the rate of one rupee per employee, employed in their industrial establishments.

The Government of Bombay (GOB) and the Bombay Municipal Corporation (BMC) each gave a grant of Rs.10,000 for a period of three years, raised to Rs. 15,000, and Rs. 20,000, respectively. At the inaugural, Turner pointed out that the death rate from tuberculosis in Bombay was 2.92 per 1000 as against 2.17 in Glasgow. Turner suggested enforcement of laws and bye-laws and made a plea against public spitting. Indian doctors endorsed the ATL [2]. Dr. Kashibai Nowrange as a medical woman observed that women more than men were susceptible, because of their 'habits' and the subject was vitally connected with sanitation and hygiene. Dr. B.K. Bhatwadekar ascribed the disease to overcrowding, insufficient ventilation, insanitary conditions and unwholesome food. Dr. T.B. Nariman contended that preventive measures were more effective than the cure for tuberculosis, Dr. A.G. Viegasobserved that tuberculosis was 'the general in the vast army of destruction [3].

The ATL devised the following plan of action: 1) notification of the disease with the cooperation of medical practitioners, 2) provision of a central dispensary and information bureau with a bacteriological laboratory, supervised by a doctor assisted by a clerk, and a compounder, 3) examination of the family and contacts, for latent and manifest infection, 4) examination of individual patients at their homes, 5) seeking the co- operation of medical officers of mills, factories, railways and docks, 6) voluntary measures for the supervision of milk and food supplies,7) medical inspection in schools, 8) hospitals for advanced cases, sanatoria and farm colonies, open air schools and segregation of infected purdah women in suitable institutions [4]. Bearing in mind the privation and destitution engendered by the disabling condition, through tuberculosis, of the breadwinner the ATL made an appeal for a special fund to relieve distress, support the family and minimise the risk of infection.

The ATL opened an information bureau and a small dispensary, for pathological examination managed by Medical Officer Dr. Constancio Coutinho, assisted by nurses, Miss Da. Costa and Mrs. H. Pathak. Patients were referred by charitable dispensaries, private practitioners, and municipal dispensaries. A small laboratory was fitted up in the dispensary to examine blood, urine and sputum of the patients and of samples received from private practitioners. Coutinho found that young adults from the ages of 16 to 20 were most prone to the disease and constituted 22.9 % of all cases in 1914, most of them being students or clerks. He observed that the number of persons living in intimate contact with their relatives were an important feature in spreading the disease. One case in a schoolmaster, milk vendor or student was capable of spreading the disease. Besides receiving instructions about regulating their life and habits, patients were treated with inhalations and tuberculin injections. Tuberculin was still on trial at the time [5]. A tuberculin outfit was made by Burroughs Wellcome & Co. Some patients gave up on their treatments when their immediate symptoms were relieved, while some gave incorrect addresses to avoid detection. The dispensary worked in close cooperation with the Municipal Health Department, nurses tracing people with the help of 'birth karkoons,' who made house to house visits to inquire about births and deaths. Nurses demonstrated the urgent need to destroy infected material and the dangers of 'promiscuous' spitting. The ATL maintained a museum, with exhibits of hygienic appliances, models and diagrams purchased from England, and a library. Lectures with lantern slides were organized, describing early signs, providing instructions for consumptives, and explaining the benefits of sunlight and pure air in English, Gujarati, Marathi and Urdu. The ATL showed that scrofulous enlargement of glands, diseases of bones, joints, and the spine, pleurisy and abdominal tuberculosis in infants and children accompanied by swelling and pain, and persistent diarrhoea were all manifestations of but one infection [6].

A branch dispensary was started, in 1915, in the crowded locality of Kamatipura, which had the highest incidence of the disease. Women engaged in beedi manufacture were found to be most vulnerable. In 1921, 1,007 patients, with women outnumbering men, were treated, at the two dispensaries.

Hospitals and sanatoria for tuberculosis patients

The ATL, emphasised the importance of hospitals for advanced cases of tuberculosis. However, the accommodation provided at Jamsetjee Jejeebhoy (founded in 1845) of 20 beds, Cama(1886) of 12 and the Adams Wylie hospitals(1902) of 10 beds proved to be inadequate. The AR hospital admitted tuberculosis patients during intervals between epidemics. Hospital authorities complained that chronic patients, requiring no treatment but shelter, food and nursing, occupied beds in incurable wards, staying even for a year, depriving other acute cases. In 1916, the BMC sanctioned the use of 25 beds at the Maratha Hospital, which had originated as a plague hospital for millhands and became a hospital for all communities. The increase in hospital admissions for the treatment of tuberculosis was attributed both to improved diagnosis and the awareness promoted by the ATL. Sir Ratan Tata's donation made possible a discretionary relief fund to give help to convalescent patients or journey fares to their 'native' places. A tuberculosis ward of 50 beds was established at the King Edward Memorial (KEM) hospital, which opened in 1926. The Consumptives Homes Society, founded by Behramji Malabari and Dayaram Gidumal in 1907, established a sanatorium at Dharampuri near Shimla. with accommodation for 90 patients, with a free block named after various donors, who included chiefs of Indian states and the general public. Sanatoriums were founded, with private funding, at Devlali, for Parsis, at Karle, by Bhatwadekar, for Hindus, and the St Joseph's Foundling Home, which took in Roman Catholic patients.

It was soon observed that social conditions made it difficult for patients to go far away. Therefore the need was to start an institution in Bombay so that relatives could go and visit them and see the benefits of the treatment. The ATL opened a sanatorium at Parel, in the property known as the 'Aina Mahal,' situated on a hill northeast to where Haffkine Institute is located. The Bhoiwada hill sanatorium, which was opened in 1918 by Governor Lord Willingdon with twenty beds, was made possible due to the generosity of the Western India Turf Club, which donated Rs. two lakhs for purchasing the property and the Bombay Government, sanctioning Rs. 25,000 towards its construction, Rs.10,000 for its maintenance, and an annual grant of Rs.20,000 from the BMC. The aim was to treat early cases, segregate advanced cases, who were admitted to prevent infections from spreading at home and treat glandular tuberculosis in children. The sanatorium provided 'a judicious mix of rest and exercise,' including parlour games, a library and a light physical drill [7]. The ATL installed an X-ray machine at the sanatorium. This was named the Turner sanatorium and was amalgamated with the Maratha hospital to form the TB hospital in 1948, with 458 beds.

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Integration of Data Science for Timely Tuberculosis (TB) Care

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Data Science can help integrate the long and complex processes of care-seeking, diagnosis, linkage to care, and treatment initiation for effective and uninterrupted treatment.

Data Science is an emerging discipline. Ubiquitous digitalization, the consequent generation of 'big' data, the capability to process the data, and the semiotics of its translation to innovate solutions to problems in healthcare and other domains are catalysts of its rapid growth. Digitalization is generating voluminous streams of numerical, textual, visual, auditory, haptic, and other types of data about our bodies, the things we use, and what we do where and when. Data Science is the science of translating this data into information, meaning, interpretation, knowledge, action, feedback, and learning. Systematically mining this large volume and variety of data can yield novel insights and innovative systemic solutions to current healthcare problems.

The current design of tuberculosis (TB) care system is dominated by the biological, medical, economic, and social sciences. Each addresses a significant part of the problem. Despite large-scale, long-term efforts with micro-biological diagnoses, medical treatments, economic incentives, and social protection for TB care in India, the problem of epidemiology and endemicity of TB persists and continues to worsen. Complementing these traditional sciences with Data Science can help systematically transform the TB care system by integrating it. Among the many transformations, Data Science can help deliver timely care.

Timeliness is central to effective TB care – delayed, uncoordinated, unscheduled care is not just ineffective; it compounds the problem of case management and coordination among ambulatory, community, and home facilities and their associated workforces. Data Science opens unique opportunities to assure timely, coordinated, and scheduled care and improve its effectiveness. India is moving rapidly to develop a national digital health infrastructure; it also carries a very high, growing burden of TB care. In this essay, we discuss how integration of Data Science with the other sciences for TB care can lead to: (a) timely identification, counselling, treatment, correction, and conclusion of care for, (b) individuals, families, communities, and the public. The logic of the essay is encapsulated in the Ontology of Integration of Data Science for Tuberculosis (TB) Care in Figure 1. The essay is in five sections corresponding to the five stages of TB care in the ontology. The discussion in the five sections is based on the concepts of a learning surveillance system for TB [1] and ActiveCase Finding for Ending TB in India [2].

Data Science for Timely Identification

The earlier a TB patient is identified and diagnosed, the shorter and more effective his/her treatment is likely to be. It would be even better if a patient is proactively managed to prevent them from becoming a TB patient – a salvage case. Timely Identification requires timely finding of patients through screening and contact tracing. These in turn are dependent on appropriate sensitization and prevention measures. The latter include assessment of risk factors, infection control, vaccination, and communication for education and behavioural change.

Data Science can be a powerful tool for screening and contact tracing, as has been demonstrated during the Covid-19 pandemic. Complementarily, Data Science can also be deployed to target sensitization and prevention measures to individuals, families, communities, and the public based on their biological, medical, social, and economic risk profile. More importantly, Data Science can be used to increase the precision and personalization of the risk profiles and hence timely identification of patients by integrating the biological, medical, social, and economic data about a target entity. Data Science can immensely improve Active Case Finding.

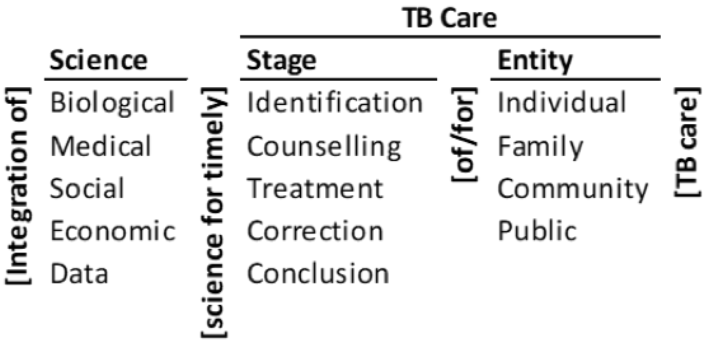

Figure 1: Ontology of integration of data science for tuberculosis (TB) care

Data Science for Timely Counselling

Ideally, the counselling of TB patients must be end-to-end from primordial prevention to relapse prevention, and continuous. Such counselling is essential to assure adherence by the patients to the treatment protocol despite the difficulty of doing so. Counselling can: (a) provide a treatment roadmap to the patients, (b) explain the challenges and help overcome them, (c) assuage their fears and anxieties, (d) address the personal, family, social, and professional stigma associated with TB, (e) help navigate logistical, financial, geographical, and temporal barriers to treatment adherence, (f) avoid extreme personal life-threatening feelings and measures, and (g) provide hope and encouragement for successful completion of the treatment. Timely counselling is a key to people-centred treatment: protect the life of the patient, alleviate his/her suffering, and control his/her future.

Timely counselling will be effective when it is based on the feedback and learning from the counselled – an individual, a family, a community, or the public. It can help adapt the counselling to the different stages of TB care, manage the dosage and its focus. It will also be effective when it integrates the evidence from the biological, medical, social, and economic sciences. Data Science can reduce the cycle-time of feedback and learning, help target it with precision, and personalize it. Data Science can help integrate and apply biological, medical, social, and economic data about an entity for effective counselling and continuum of care under various socio-economic circumstances.

Data Science for Timely Treatment

The TB care protocol can be complex and multi-stage. The cascade of care must be adapted based on the patient's response and must be adhered strictly. Timely treatment intervention is critical to the successful conclusion of the protocol and completion of uninterrupted treatment. Delays may not only delay the conclusion of the treatment but may also compound the problem. The timely treatment must be sustained despite the many logistical, financial, geographical, and temporal barriers.

Data Science can aid to make the treatment supply network more effective and efficient for both care provider and the receiver. It can help optimize the virtual/physical treatment balance, appointment scheduling, patient transportation, and medication delivery. The optimization may be at the level of the individual, family, community, and the public at large. Data Science can help integrate the long and complex processes of care-seeking, diagnosis, linkage to care, and treatment initiation for effective and uninterrupted treatment.

Data Science for Timely Correction

Often, the progression of TB is a consequence of inappropriate and/or inadequate treatment, including drug susceptibility methods for selecting effective regimens. To overcome low predictability associated with clinically irrelevant and low reliability results of drug susceptibility testing adopted, it is important to proactively recognizing non-compliance with treatment protocol, and non-adherence by patients to help prevent the progression of TB. It will enable effective treatment in resource-constrained high-burden countries.

Data Science provide the decision support to determine deviations from the trajectory, analyze the reasons for the same, and recommend the future course based on the feedback. The recommendation may reinforce improvements, continue normal movements, and redirect deteriorations in the condition of the entity.

Data Science for Timely Conclusion

DRTB treatment can be long and difficult. Timely conclusion can bring necessary closure to patient and the providers. It can also motivate them by providing a target to plan the treatment regimen, motivate providers to comply with it, motivate patients to adhere to it and correct it when necessary.

Data Science can aid bring treatment to a timely conclusion in several ways. First, by collating all the data that are spread over many databases and stretched over a long period of time to arrive at a considered decision. Second, by assisting the provider and receiver monitor the trend before and after the conclusion. Third, by integrating the best biological and medical evidence to determine the conclusion.

Digitalization of Healthcare in India

India is digitalizing rapidly in many sectors, including healthcare. The digitalization is being driven by both the public and private sectors. The Central and State governments are committed to digitalization and have rolled out many successful programs that substitute physical transactions with digital ones.

Image from Analytics Vidhya

India's digitalization poses both opportunities for and threats to applying Data Science for TB care. For example, the NIKSHAY TB is a national digital platform that can be harnessed for TB care in conjunction with schemes like Ayushman Bharat for healthcare, Jan Dhan for financial transactions, and systems for surveillance and vaccine administration that have been developed in response to the Covid-19 pandemic. The threats pertain to fragmentation in governance, systems, processes, personnel, location, and schedules. In addition to these, the national data protection/storage requirements may be an important threat.

Despite their gravity, the threats can be surmounted – they have been in the financial services sector, e-commerce, airlines, and even in healthcare to a limited extent. A recent example is the nationwide Covid-19 vaccination registration and administration system. In these sectors digitalization has helped penetration of services to traditionally underserved segments of the population, and to scale up the services by orders of magnitude. Data Science for timely TB care can draw lessons from these local successes. The ontology can be used to map the pathways for integrating Data Science with timely TB care, and Data Science with other sciences for such care.

Conclusion

The time is ripe for the proposed Data Science integration for timely TB care. It must proceed in stages. While data is in the foreground of digitalization of healthcare in India Data Science for healthcare is in the background. Integrating Data Science with the other sciences is further behind in India's plans. There is no mention of integration of Data Science for TB care or for timely TB care.

The pieces are being positioned in silos. They must be put together. Data Science for timely TB care in India could be a pilot to prove the concept and subsequently extended to Data Science for TB care. The lessons of Data Science for TB care can be generalized to Data Science for healthcare in India.

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India's digitalization poses both opportunities for and threats to applying Data Science for TB care.

Habitat Monitoring for TB Risk Mitigation and an Integrated Information-based Decision Making Framework for Dense Urban Settings: An Approach

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The impact of the unclean and crowded living conditions, especially those experienced in the thickly populated slums of the developing countries, towards enhancing the risk of tuberculosis (TB) infection is well known, and the same has been documented previously [1-3]. Historically, TB has been a disease associated with poor people across the world. On an average about 2–3 million people succumb to this neglected yet lethal disease. Of this population, a large fraction belongs to the underprivileged habitats in the developing countries and the poor, urban neighbourhoods in wealthier, advanced powers [1].

Although identifying this issue has taken place, the strategies to deal with it from a habitat planning point of view are yet to be articulated in the form of actionable recommendations. The strategies adopted by the World Health Organization (WHO), the United States Agency for International Development (USAID), The Global Fund, and other large organizations towards controlling the spread of TB and the mitigating the risk of infection have been largely revolving around clinical solutions in the form of drugs, vaccines, and access to healthcare [1, 4]. Consequently, the impact of the physical environment of the habitat on the incidence and sustenance of TB in the individuals has been neglected by and large, in both industrialized and non-industrialized countries [1].

Despite 'crowding' being a crucial factor associated with infection risk for several decades, quantifying the impact of over-populated habitats on the incidence and propagation of TB is not simple. A straightforward data-driven evaluation metric is yet to be formulated. However, there is an immediate need to formulate the template for a consolidated checklist that covers the critical questions pertinent to the incidence and aggravation of TB due to poor habitat conditions. Such a template will aid in streamlining the flow of information. From the organized pool of information, salient takeaway points pertinent to the control and management of TB can be derived, and those can be integrated with the existing monitoring frameworks that are used in assessing and improving the Quality of Life (QoL) in unacceptable and untidy crowded habitats.

Published literature indicates some of the established methodologies to monitor the progress of the targeted programmes aimed at improving the QoL for the urban slum dwellers. In this context, it is important to note that one of the key targets mentioned in the Millennium Development Goals (MDGs) brought forth by the United Nations is to 'achieve significant improvement in lives of at least 100 million slum dwellers, by 2020' [5, 6]. The operational definition for the sub-city level slum settings is often woven around a few key indicators, such as access to water and sanitation, sufficient living area, a house with durable material on a non-hazardous location and with tenure security. However, more recent studies provide a deeper insight regarding the TB risk factors emanating from indoor environments. Some of the key elements within the household physical environment that could emerge as TB aggravators are – existence of smoke inside the house for prolonged hours, use of solid fuel used for cooking, lack of separate spaces for cooking (often the living room and the kitchen are the same), use of mud or natural material for making floor, roof & the walls, large number of persons sleeping together in a room, sharing of toilets with other households, and shortage of drinking water [3].

To weave this detailed information intricately into the intervention strategy aimed at improving health and habitat in the underprivileged areas (e.g., slum pockets within the densely populated metropolitan cities, slum areas alongside the broad-gauge railway lines that run from the cities into the smaller municipal towns), intimate knowledge regarding the physical conditions of the neighbourhood is needed. A spatial information repository can be developed with extensive use of geospatial techniques that encompass geo-visualisation and may involve multiple layers of mapping.

A complete picture of the living conditions can be captured by working closely with the local planners, infrastructure engineers, and more importantly with the local communities. This information will provide insights into the hardship of communities in terms of the physical environment offered by the habitat, as well as into the criticality of TB- related environmental attributes that might pose a serious risk of community-scale TB infections and subsequent aggravation [3].

In the modern era of cutting-edge and emerging technologies, advanced technological tools are evolving that can aid in simulation and visualization of complex scenarios leading to informed decision-making, aided by adequately accurate prediction and intelligent actuation [7].

Augmented Reality (AR) can be used as a very efficient tool for habitat monitoring as it supplements the view of the physical world with computer-generated content, usually in the form of texts, images, audio-visuals, 3D objects etc. The modern day state-of-the-art smart mobile devices with high computational capabilities and three-dimensional interactive geospatial visualization (3D GIS) have opened up an array of novel possibilities [8].

The combination of ground truthing and the geospatial information in an integrated framework enabled with Artificial Intelligence (AI) capabilities can bring a revolution in the habitat monitoring. If TB monitoring can be integrated with this framework using the nuances derived from community-level surveys, that will enable bridging of gap between the administrative tier and on-ground operational tier engaged in eradicating the curse of tuberculosis across the world.

For these purposes, location-based marker-less AR technology may also be suitable as it does not require prior knowledge of a user's environment to overlay a 2D or 3D content into a scene (area of interest) and for holding it to a fixed point [8].

The fundamental goal of a generalized AR framework is to incorporate computer-generated input into real-world experience. Since this technology uses data from camera systems, dedicated sensors and deploy complex data interpretation (DI) algorithms for accurate detection and mapping of the physical environment, the resource requirements need to be evaluated at the planning stage. Since the technology can be accessed through devices like smartphones, laptops and even headsets, it is quite user-friendly.

Mapping is the most important feature associated with any marker-less AR tool/ app. In a location-based marker-less AR tool, the first step is Scene Recognition to recognize and track large objects like housings, rooms etc. [9]. Thereafter, simultaneous/synchronized localisation and mapping (SLAM) is needed.

SLAM denotes mapping of an area whilst keeping track of the location of the device within that area. Using such a technique mobile mapping is possible. SLAM allows a user to map large areas within reasonably shorter durations, as the areas can be mapped using mobile robots, vehicles, or even drones. SLAM systems are suitable for both outdoor or indoor environments and they simplify the data collection process [10]. Sensors deployed in a SLAM system use different sources of data (visual, non-visible) and at times they also utilize basic positional data, using an inertial measurement unit (IMU). Using the sensor data, the device computes a 'best estimate' of its own location. The estimate is improved as new positional information is collected frequently.

Once the mapping is done, specialized plugins may be used to create 2D/3D objects for incorporation into the scenes. These objects may include customized information (habitat-indoor physical environment and surroundings, TB-risk assessment data) based on the requirement, for enhancing the experience of the user.
Thereafter, Geolocation Application Programming Interface (API) allows the user to provide their location to web applications. Finally, the integration with open-source mobile app platforms is needed.

AR tools can provide information for both indoor physical environment and the habitat surroundings. The real-estate sector often uses popular AR browsers for gathering the vicinity information around chosen area. AR browsers have also been used for searches related to interior designs [11].

Using such tools, necessary development measures encompassing maintenance of cleanliness, remodelling of housings to add more space, improvement in sanitation and drinking water supply can be planned. This can happen in conjunction with the TB-related measures such as – collecting information regarding the infected individuals, collecting information regarding the locality, spacing of the houses, survey of population density and locality-wise quality of life (preferably at the ward level) etc.

Figure [1] schematically shows the conceptual template for the envisaged data integration for the necessary interventions. As evident from the figure, evaluation of the habitat monitoring framework and ground-level assessment of the TB Risk emanating from the habitat conditions are to be done periodically. Necessary course corrections should be incorporated in the template used for information integration. Once the reliability of the framework is established through pilot studies, the generated composite information can be used for decision making pertinent to remedial interventions, both for habitat improvement and TB risk mitigation.

Such a framework may also include open-source mobile technology for rapid TB diagnosis, which would prove to be a boon for the communities with limited resources, i.e., those residing in remote areas with few clinics, and diagnostic tests. This would do away with a lot of logistical hurdles associated with the delay in processing the test samples, that tend to hinder the immediate treatment. In addition, this will also make the follow ups a lot more streamlined as the chance of the lab results getting compromised or lost is greatly reduced by enabling biometric verification process [4].

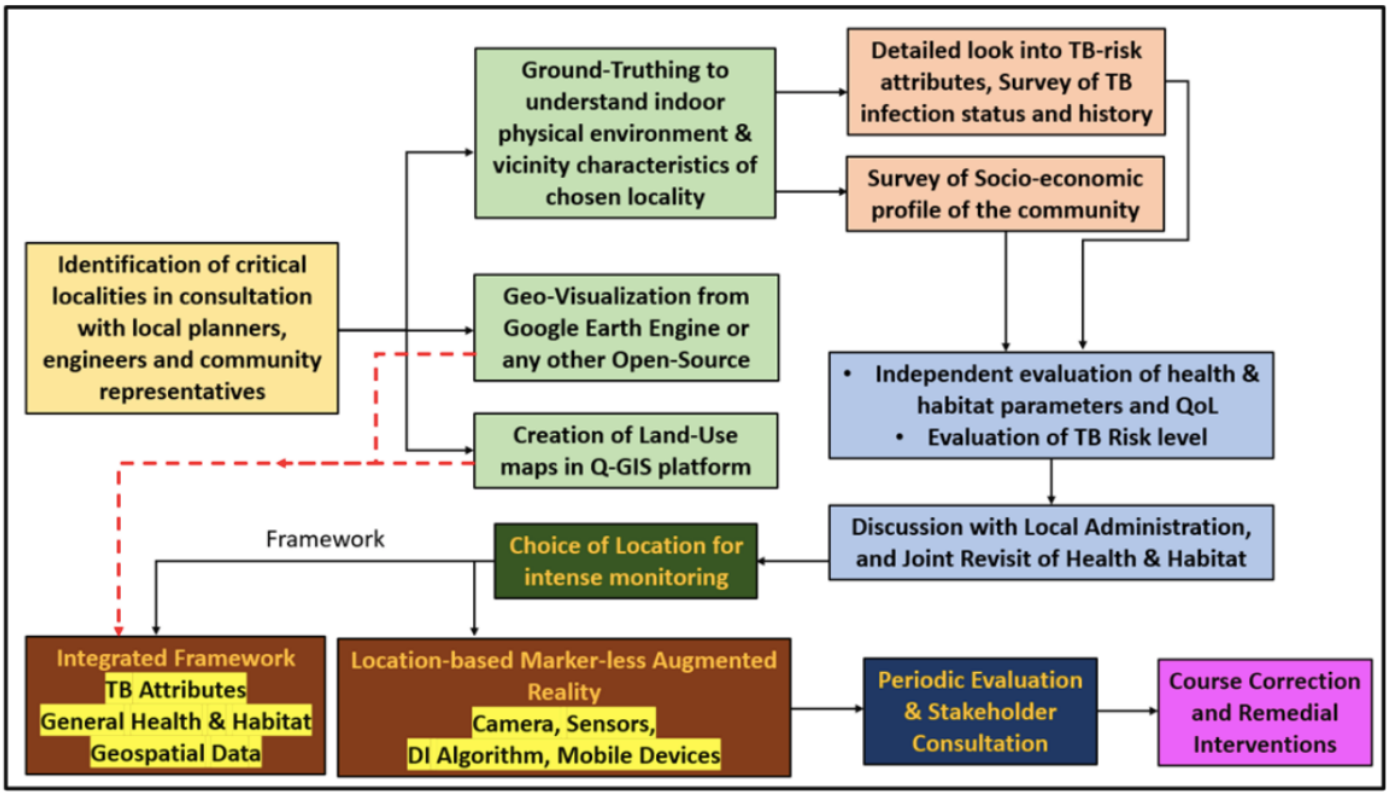

Figure [1]: Information Flow and Integrated Framework for Health & Habitat Monitoring and TB Risk Mitigation in Urban Settings

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Recurrent TB Infection–A Nightmare!

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Tuberculosis disease among previously treated individuals (recurrent TB) constitutes 5– 30% of the TB burden. There has been much effort to make a difference between Relapse & Recurrence. "Recurrence", is generally considered as "the second episode of tuberculosis, after the cure of the first episode". Recurrence may be due to endogenous relapse or exogenous reinfection [1]. Repeated recurrences in the same individual add to the TB burden, but the extent has not been quantified due to difficulties in identifying recurrence in routinely collected data [2]. Therein lies a challenge that needs to be addressed.

Image from Manipal Hospitals

This is a brief story of a woman, educated and working in UK and who had to undergo multiple episodes of recurrence.

Mrs R, aged 25 years, consulted me in May 2012 with a history of backache of four months and swelling around the neck of two months. She was based in UK but arrived in India for treatment based on her not-so- good experience managing her disease there. In UK, she had visited her GP in early February 2012 with a complaint of vague backache of short duration post-pregnancy. Since she had no relief, the GP ordered a chest x-ray that showed normal lung pathology and a mild lower thoracic scoliosis. A subsequent spine x-ray done on 27th February revealed T8 bone loss with bilateral mild paraspinal swelling.

An MRI done on 1st March 2012 was reported as chronic T8-T9 discitis with a large anterior lobular subligamentous abscess and also another abscess lying deep to PLL (posterior longitudinal ligament). No cord compression was found. Minimal involvement of T5, T10 & T11 was seen. Another lesion at L3 was seen. Final Impression: Chronic infection to be considered, including TB.

This was sent for urgent cancer referral to London Bone & Soft tissue Sarcoma Service: it was reviewed & referred back to the local spinal team on the 12th Mar 2012. They reviewed the case history but wanted more time for making the line of treatment. Hence she landed in India in late April 2012 with back pain and with additional neck swelling for treatment.

Image from Metropolis Health care

She was referred to me, and a brief history & findings suggested a clinical diagnosis of TB Spine. Since she had multiple cervical lymph node involvement, I requested the surgical team for a FNAC/ Biopsy to make a tissue diagnosis. We repeated a few Investigations to know the progress of the disease. Routine blood investigations were normal. Chest X-ray was clear. X-ray of TL spine showed features suggestive of Pott's spine with T8-T9 involvement. Paravertebral soft tissue shadow was seen from T6 to T11. MRI of the Thoracic spine showed multiple level involvements with kyphotic deformity at T8-9 spine with collapse. A FNAC was done for a lymph node in the left submandibular region. Impression was acute suppurative pathology, no granulomas seen. However, ZN (Ziehl Neelsen Acid-fast stain) staining was non- confirmatory. Hence an excision biopsy of the cervical lymph node was done on 10th May 2012. HPE (histopathologic examination) reported on 15th May 2012, as caseating Tuberculous Lymphadenitis.

The Plan of Treatment was AKT-4 (4 drug regimens) for three months & AKT-3 (3 drug regimens) for nine months. No surgical treatment for the spine was contemplated, given multiple skip lesions in the spine and having no neurological disturbances. The patient was regularly reviewed once a month for six months. She improved remarkably with weight increase and improvement in appetite. Her back pain had disappeared. Lymph nodes reduced in size. X-ray Spine showed a reduction in paraspinal shadow. After six months, she left for UK and completed her entire course of treatment for one year ending May 2013 in UK. She had recovered fully.

In July 2014 (14months after stopping ATT), she again noticed a lump in the submandibular region. All investigations were normal, and a FNAC was non-diagnostic. Her spine X-ray showed bone healing, and paraspinal shadow had disappeared. A differential diagnosis was done between a Koch's and a primary lymph gland swelling. She was found to be vitamin D deficient. She was started on Quadruple therapy, which compromised of Rifampicin, Isoniazid, Pyrazinamide & Ethambutol for two months in August 2014. She was on Pyridoxine support and vitamin D supplements at the same time. After two months, she was started on the two- drug regimen for the next four months. All her symptoms and swelling had totally reduced. One of the views put forward by her UK Physician was that deficiency of vitamin D would have triggered her second recurrence of TB. On 21st Aug 2021 (7 years after the 2nd episode), she came to me with a history of neck swelling. She had relocated to India and was fine till she noticed swelling around the neck. All Blood parameters were normal. MRI showed fusion of T8-9, no paravertebral shadow. The rest of the spine was normal. A Surgical opinion was taken who advised repeat FNAC, which was not conclusive and hence excisional biopsy was done. GeneXpert MTB/RIF was done, and it showed Mycobacterium tuberculosis. Incidentally, her vitamin D level was very low. HPE showed TB Lymphadenitis. Patient is under surgical care. They have again started on a four-drug regimen for two months, followed by three drugs for two months and, now undergoing two-drug regimens for the next four months as advised by her present surgeon. Her neck swelling has reduced. Investigations are normal.

Conclusion:

Many studies reveal that recurrence in patients who were adequately treated was higher than that of new TB [3]. The recurrence rate is highly variable and has been estimated to range from 4.9% to 47%. Most recurrences happened within 2-years after completion of anti-TB treatments. However, there are reports of recurrence even after ten years. In the above case, the first recurrence was seen after 14 months, and the second recurrence was after six years. The important message to note is that these are not isolated or rare cases. The risk is more among smokers, patients with co-morbid conditions, HIV & malnutrition group. The high prevalence of vitamin D deficiency in pulmonary TB patients indicates that vitamin D is a risk factor for the development of active tuberculosis [4]. Therefore, maintaining vitamin D status in TB patients might be helpful to controlling tuberculosis [5,6]. The High incidence of recurrence demands a need to improve the quality of TB care through regular follow-up after completing treatment as part of an established disease control strategy. The use of technology for regular follow-up will add great value addition. With every person connected to a mobile phone, monthly follow up of cured and completed sputum smear-positive for the reappearance of symptoms can be planned using mobile applications which will be cost-effective, less human dependent and capable of picking up symptoms early. There is no doubt that with better technology and better access, the possibility of reducing the quantum of tubercular infection is not far off, provided we have the purpose of doing so.

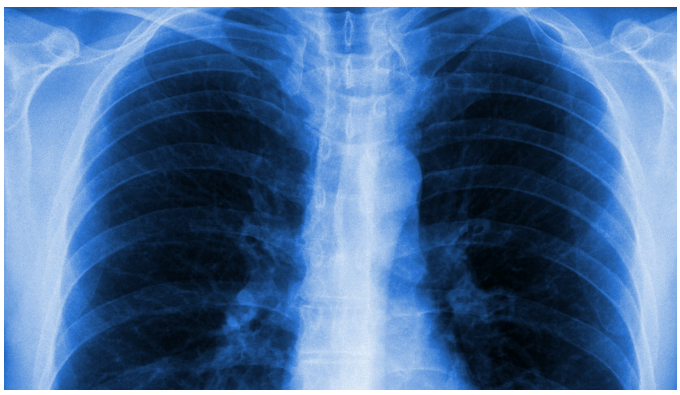

Image from Medical News Today

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MYTHS AND REALITY IN TUBERCULOSIS

Prof. (Dr) V.K. Arora, Former: Director, National Institute of TB and Respiratory Diseases (LRS) & Additional DGHS, Govt of India; Present: President, SEAR- South East Asia Region (UNION) & Trustee, Tuberculosis Association of India, New Delhi, India

Myth: Tuberculosis is a curse.

Reality: This is a false notion. This is caused by tuberculosis bacteria, which originated in East Africa about 3 million years ago. TB was found in mummies around 15000 years back. Since it is caused by TB bacteria, therefore it can occur in rich and poor persons. It can be prevented by taking appropriate measures and precautions.

Myth: TB is a Genetic disease (Family disease).

Reality: Contrary to some beliefs, TB does not come climbing down a family tree. Instead, it occurs due to Tb bacteria. When a patient coughs, bacteria are released into the air, and droplets remain suspended in the air, which can infect anyone within striking distance.

Myth: There is no cure for TB.

Reality: This is false; TB is treatable, curable and preventable. For treating TB, combinations of drugs are prescribed. In order to get cured, it is important that you must adhere to the therapy for at least 6-9 months.

Myth: TB is always fatal.

Reality: TB can be fatal without treatment, but with modern medicine, doctors can successfully treat and cure the illness.

Myth: On 24th March, we celebrate the birthday of the TB discoverer.

Reality: Dr Robert Koch was born in Germany on 11th December 1843. On 24th March 1882, he discovered that tuberculosis is caused by Mycobacterium Tuberculosis. This discovery paved the way for diagnosing TB and treatment.

Myth: TB only affects people in low-income countries.

Reality: TB can affect people anywhere in the world. Those persons who have Comorbidities like diabetes, alcoholism, cancer therapy or on corticoids, and or HIV have more chances of developing the same. India counts for around 30 per cent of TB cases and is one of the eight high burden countries.

Myth: Tuberculosis bacteria causes only tuberculosis in the lungs.

Reality: Tuberculosis bacteria can affect any part of the body i.e. lungs, abdomen, brain, bones, eyes, endometrium etc. TB antibiotics are effective in all types of tuberculosis except for little modifications.

Myth: Tuberculosis May not kill but continue to stay in patients.

Reality: According to the World Health Organization (WHO), TB was responsible for 1.4 m global deaths in 2019. India is a high burden country with National Tuberculosis Elimination Program in place. India will like to eliminate TB by 2025 by achieving targets of SDG (sustainable development goals) of reduction of incidence by 80 per cent and mortality by 90 per cent with a baseline of 2015. In view of an increase in drug resistance TB, A threat is posed to achieving the above targets.

Myth: Tuberculosis spread by shaking hands, utensils of TB patients etc.

Reality: Shaking hands, sharing foods or beverages, touching bed linen or toilet seats, kissing and sharing toothbrushes can't spread tuberculosis. It spreads by bacteria of tuberculosis which float in the air during coughing and sneezing of patients having active disease.

Myth: Cough is socially accepted and does not spread Tuberculosis.

Reality: Tuberculosis (TB) is a potentially serious infectious disease that mainly affects the lungs and other organs of the body. When the patient coughs, the bacteria through droplets spread in the air. The longer the patient remains ill without proper diagnosis and treatment, the longer he can infect the community. Evidence suggests that one patient can infect more than 25 patients before the diagnosis is made.

Myth: TB patients must get admitted to the sanatorium and cannot travel to meet their relatives.

Reality: Most important part nowadays of tuberculosis is that you can have the domiciliary treatment, and after 7 to 10 days if the patient feels an improvement, then he can meet his relatives.

Myth: Mother cannot give breast milk to her baby.

Reality: If the mother can use the proper mask and washes her hands properly, then she can give the breast milk to the baby. In fact, effective anti-TB therapy can make the mother non-infective in 7 to 10 days of treatment, and she can continue to breastfeed the child.

Myth: Tuberculosis cannot be treated without a high nutritive diet. Reality: Even though nutrition is an important part, it cannot replace effective anti TB drugs for killing the TB bacteria. Therefore, compliance with anti TB therapy is an essential step for the cure of patients.

Suggested Readings:

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World Tuberculosis Day Invest to End TB and Save Lives

Dr. M Sai Baba, Visiting Professor, NIAS & Director Ramaiah University of Applied Sciences Bengaluru, India

Respiratory infections have been haunting humanity for a long time, and Tuberculosis is one such primary infection. The world woke up to the challenge of the COVID-19 pandemic indicating how deadly respiratory illness can be. It is a grave reminder that health threats can travel faster across the continents. Tuberculosis has been present in humans since ancient times. Skeletal remains show that some prehistoric humans had TB. Researchers have found tubercular decay in the spines of Egyptian mummies dating from 3000 to 2400 BC [1]. World Tuberculosis Day is commemorated on March 24. The date marks the day in 1882 when Dr Robert Koch announced the discovery of identification of the bacterium that causes TB, which opened the way towards diagnosing and curing this disease. In 1982, on the one-hundredth anniversary of Robert Koch's presentation, the International Union Against Tuberculosis and Lung Disease (IUATLD) proposed to declare March 24 as an official World TB Day [2]. Almost a decade has passed to pronounce March 24 as World TB Day by the United Nations. Observation of the day is to raise awareness about the devastating health, social and economic consequences of TB and step- up efforts to end the global TB epidemic. Tuberculosis is an infectious disease usually caused by the bacteria, Mycobacterium tuberculosis (MTB). TB generally affects the lungs but can also affect other body parts. Most infections show no symptoms (latent TB), and ~10% progress to active disease. It was historically called consumption due to weight loss. Infection of other organs can cause a wide range of symptoms.

Image from https://www.corporatetbpledge.orgcsr

TB is a global disease found in every country in the world. TB remains one of the world's deadliest infectious killers. Each day, nearly 4000 lose their lives to TB, and close to 28,000 people fall ill with this preventable and curable disease [3].

It is estimated that one-quarter of the world's population has a latent infection with TB. New infections occur in about 1% of the population each year. Most TB cases occur in South-East Asia, Africa, and the Western Pacific. More than 50% of patients are diagnosed in eight countries: India, China, Indonesia, the Philippines, Pakistan, Nigeria, and Bangladesh. Indicating hope, the number of new cases each year has decreased since 2000. However, it is estimated that about 40% of the Indian population is infected with TB bacteria, most of whom have latent TB rather than TB disease. WHO assessment puts the TB incidence figure of 2.64 million cases in India, about 193 per 100,000 population [4]. Antibiotic resistance is a growing problem leading to increased multiple drug-resistant Tuberculosis (MDR-TB) and extensively drug- resistant Tuberculosis (XDR-TB). Prevention of TB involves screening those at considerable risk, early detection and treatment of cases, and BCG vaccination. Treatment requires the use of multiple antibiotics over a prolonged period. WHO-recommended Directly Observed Therapy, Short-Course (DOTS) treatment to patients [5]. Deprivation of nutritious food due to poverty and lack of adequate health infrastructure resulted in the prevalence of TB [6].

The incidence of TB in wealthier nations is reducing, and so is the focus of the research. Sadly, most research relating to curing diseases and drug discovery is western-driven. The governments of developing nations need to wake up to the reality, enhance funding, and support research in finding cures for diseases affecting their people. Another worrying aspect of TB is the fear of not being able to or afford to cure it. Stigma is attached to TB. Earlier methods of dealing with TB isolate people, and several cities have Sanitoriums where infected people are isolated and given treatment. Many vivid accounts are shared on social media about the problems and situations dealing with Depression or Alcoholism. It is rarely seen any such social media activity about TB.

A WHO estimate puts that since 2000, an estimated 66 million lives have been saved due to global efforts to combat TB [7].

The COVID-19 pandemic and its impact led to the reversal of the years of progress made. An increase in deaths due to TB is seen. The Clock is Ticking. The world is running out of time to act on the commitments to end TB made by global leaders. Invest in ending TB and saving lives.

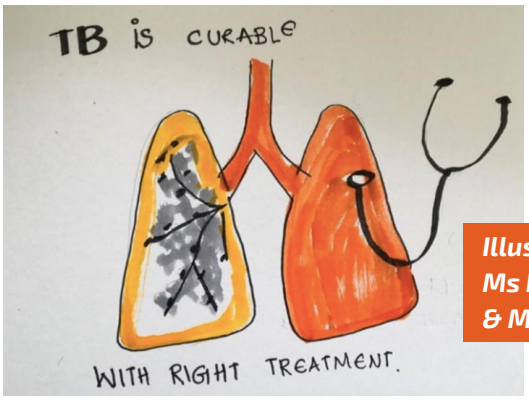

Illustration by Ms Reema Jaiswal & Ms Anusha Thati

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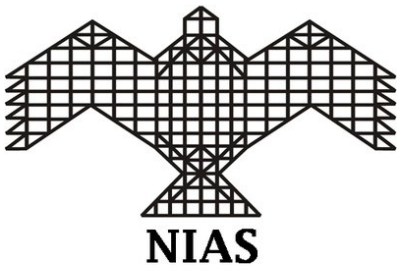

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