

Review Article

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## Tuberculosis: A Comprehensive Study with Respect to Current Situation and Overview of Tuberculosis Control Programs in Northern India

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### ABSTRACT

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Tuberculosis is an infectious disease that most often affects the lungs and is caused by the bacilli *Mycobacterium tuberculosis*. Tuberculosis is an air borne disease, it First discovered in 1882 by Robert Koch is also known as Koch's bacillus. *Mycobacterium tuberculosis* is a complex disease that can cause tuberculosis include *Mycobacterium Bovis*, *Mycobacterium microti* and *Mycobacterium africanum*, *Mycobacterium microti* isn't known to be get Tuberculosis in humans; infection with *Mycobacterium africanum* is very rare, while *Mycobacterium bovis* has a broad host range and is the main cause of tuberculosis in other animal species. Humans come infected by *Mycobacterium bovis*, generally via milk, milk products or meat from an infected animal. Tuberculosis infection in healthy people is frequently asymptomatic. Tuberculosis forestallment and control activities Patients whose mycobacterium are resistant to Rifampicin, Isoniazid and other anti-TB medicines require longer, precious and more toxic treatment rules and are less likely to be cured.

### Introduction

Tuberculosis (TB) is one of the most ancient disorders of mankind, with molecular evidence going back to over 17,000 times (Gursimrat K. Sandhu, 2011). In the malignancy of newer modalities for diagnosis and treatment of Tuberculosis (TB), it is a worldwide air borne infection leading the cause of death among HIV-infected people (Matteo Zignol *et al.*, 2012). In India, historically stating the fight against Tuberculosis (TB) can be broadly classified into three ages early period, before the discoveries of X-Rays and Chemotherapy,

post-independence period, during which civil Tuberculosis (TB) control programs were established and implemented; and the current period during which the ongoing WHO- supported TB control program is in place (Sanyaolu *et al.*, 2019).

Moment, India's DOTS (directly observed treatment-short course) program is the fastest- developing and the largest program in the world in terms of cases initiated on treatment; and the second largest, in terms of population coverage (Jane *et al.*, 2023). Major challenges to control TB in India include poor primary health- care structure in

pastoral areas of many states; limited private health care conducting to wide irrational use of first- line and alternate- line anti-TB medicines; Tuberculosis (TB) is one of the most ancient diseases of mankind and has co-evolved with humans for numerous thousands of times or maybe for several million times (Alexander Muacevic *et al.*, 2023). Although as early as tubercles,” due to the variety of its symptoms, TB wasn't linked as a single disease until the 1820s, it was established by Dr. Richard Morton that the pulmonary form was associated with “and was eventually named “tuberculosis” in 1839 by Johann Lukas Schönlein (Manaf AlMatar *et al.*, 2017). In 1882, the bacillus causing tuberculosis, *Mycobacterium tuberculosis*, was discovered by Robert Koch and for this discovery he was awarded Nobel Prize in physiology or drug in 1905, The top cause of mortal tuberculosis is *Mycobacterium tuberculosis*, Other members of the *Mycobacterium tuberculosis* complex that can cause tuberculosis include *Mycobacterium Bovis*, *Mycobacterium Microti* and *Mycobacterium Africanum*. *Mycobacterium Microti* isn't known to beget Tuberculosis in humans; infection with *Mycobacterium Africanum* is very rare, while *Mycobacterium Bovis* has a broad host range and is the main cause of tuberculosis in other animal species (Schluger *et al.*, 1997).

Humans come infected by *Mycobacterium Bovis*, generally via milk, milk products or meat from an infected animal infection in healthy people is frequently asymptomatic (Barberis *et al.*, 2017). This bacterium lives and multiplies in the macrophages, thus avoiding the natural defense system in the case's serum. Infection with tuberculosis can affect in two stages asymptomatic Idle Tuberculosis Infection (LTBI) or tuberculosis disease (James *et al.*, 2016). Surveillance of resistance to drugs against tuberculosis (TB) is a foundation of any TB control programme (James *et al.*, 2016). Surveillance data on medicine resistance are needed to track the effectiveness of TB forestallment and control activities Patients whose mycobacterium are resistant to rifampicin, isoniazid and other anti-TB medicines require longer, precious and more toxic treatment rules and are less likely to be cured (Thomas R. Frieden, 2002). This presents a redoubtable challenge to programmes, specifically by low- resource settings.

### Discovery of Tuberculosis

The disease of Tuberculosis is discovered by Dr. Robert Koch On March 24, 1882. In 1905, Dr. Robert Koch was awarded by the Nobel Prize in medicine.

### Types of Tuberculosis

Primary TB  
Latent TB  
Active TB  
Active TB outside the lungs

### Etiology Agent *Mycobacterium tuberculosis*

*Mycobacterium tuberculosis*, also known as Koch's bacillus, is a classification of pathogenic bacteria in the family *Mycobacteriaceae* and the causative agency of tuberculosis First discovered in 1882 by Robert Koch (Barberis *et al.*, 2017).

*Mycobacterium tuberculosis* has an unusual, moldable coating on its cell face primarily due to the presence of mycolic acid (Jane *et al.*, 2023). This coating makes the cells impermeable to Gram's Staining, and as a result, *Mycobacterium tuberculosis* can come out weakly Gram negative are used rather to identify *Mycobacterium tuberculosis* with a microscope (James *et al.*, 2016).

The physiology of *Mycobacterium tuberculosis* is largely aerobic and requires high situations of oxygen. Initially a pathogen of the mammalian respiratory system, it infects the lungs (James *et al.*, 2016). The most frequently used individual styles for tuberculosis are the tuberculin skin test, Acid-Fast Stain, Culture, and Polymerase Chain Reaction (PCR) (James *et al.*, 2016).

### Pathogenesis

*Mycobacterium tuberculosis* is an airborne pathogen (Gursimrat K. Sandhu, 2011). Once inhaled, droplets bearing the mycobacterium settle throughout the airways (Gursimrat K. Sandhu, 2011).

Most of the bacilli are trapped in the upper parts of the airways where the mucussecreting goblet cells are located (Sanyaolu *et al.*, 2019). The mucus catches the invading bacilli, and the cilia on the surface of the cells constantly undulate to move the mucus and trapped foreign particles upward for removal (Sanyaolu *et al.*, 2019).

This system provides the body with an initial physical defense that prevents infection in most persons exposed to tuberculosis (Sanyaolu *et al.*, 2019). The pathogenesis of tuberculosis involves a dynamic interaction between

host and pathogen (Jane *et al.*, 2023). From the time of Koch's identification of the causative agent of tuberculosis until relatively recently, progress had been relatively slow in understanding the basic biology of *Mycobacterium tuberculosis* (Jane *et al.*, 2023).

### **Morphology of *M. tuberculosis***

These bacilli are generally non-spore forming, aerobic, non-motile Gram-positive, acid-fast bacilli species (Gursimrat K. Sandhu, 2011). *Mycobacterium* is often described as “0.2–0.6 µm by 1.0–10.0 µm, straight or slightly curved rod-shaped bacteria, sometimes branched, acid-fast. “Colonies of *Mycobacterium tuberculosis* are Rough, Crumbly, Waxy, Non-Pigmented (buff colored) and slow-growers (Sanyaolu *et al.*, 2019).

- ✓ Straight or slightly curved thin rod-shaped bacilli.
- ✓ Non-sporing, non-motile, non-capsulated bacteria.
- ✓ Acid-fast bacilli, neither gram positive nor gram negative.
- ✓ During acid-fast stain, they appear bright red to intensive purple with green/blue background.
- ✓ They measure 0.5 µm x 3 µm.
- ✓ Appears in single, in pairs, or small clumps.
- ✓ The high content of mycolic acid (50 to 60 %).
- ✓ The cell wall is rich in lipids and waxes.
- ✓ They are wrapped together due to the presence of fatty acids.
- ✓ Capable of intracellular growth.
- ✓ They are resistant to disinfectants, detergents, common antibiotics, dyes, stains, osmotic lysis, lethal oxidation, etc.

### **Symptoms**

The symptoms of tuberculosis are: Chest pain, Loss of appetite, Weakness, Weight loss, Sudden Sweating at night, Very pale skin, Nausea, Fever, Dyspnea, Tiredness (James *et al.*, 2016).

### **Methods and Diagnosis**

The most frequently used diagnostic methods for Tuberculosis are the Tuberculin skin test, polymerase chain reaction & Chest X-Rays (CXR) (James *et al.*, 2016). Other microbiological investigation for *Mycobacterium tuberculosis* are Acid Fast Staining (AFB Staining), Gram's Staining, Zeihl-Neelsen staining (James *et al.*, 2016).

### **Diagnosis**

The diagnosis of disease tuberculosis can be done by performing several tests like:

Blood Test, Sputum Test, X-Ray, Specimen Cultures (James *et al.*, 2016).

### **Treatment**

Most cases are cured with antibiotics, but it takes a long time (Manaf AIMatar *et al.*, 2017). You have to take medications for at least 6 to 9 months, a combination of medicines also treats Tuberculosis (Manaf AIMatar *et al.*, 2017). The most common are Ethambutol, Isoniazid, Pyrazinamide, and Rifampin. You'll take them for 6 to 12 months (Manaf AIMatar *et al.*, 2017).

### **Drug-Resistant Tuberculosis**

Drug-Resistant Tuberculosis is transmitted in the same way as drug-susceptible Tuberculosis, and it is as infectious as drug-susceptible tuberculosis (Manaf AIMatar *et al.*, 2017). However, delay in the recognition of drug resistance or prolonged periods of infectiousness may facilitate increased transmission and further development of drug resistance (Manaf AIMatar *et al.*, 2017).

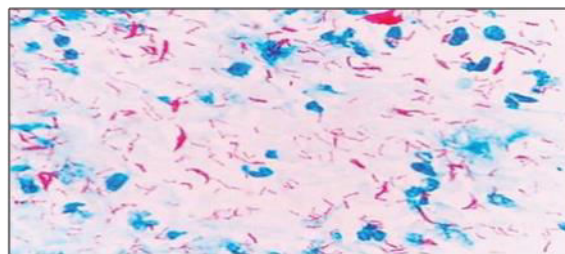
*Mycobacterium tuberculosis* strains that are resistant to the two most potent anti-tuberculosis drugs, Isoniazid and Rifampicin, are termed as multidrug-resistant tuberculosis (MDR-Tb) strains (Schluger *et al.*, 1997).

Extensively drug-resistant Tb is a form of Tb caused by bacteria that are resistant to Isoniazid and Rifampicin, as well as to any fluoroquinolone and any of the second-line anti-Tb injectable drugs (Amikacin, Kanamycin or Capreomycin) (Matteo Zignol *et al.*, 2012).

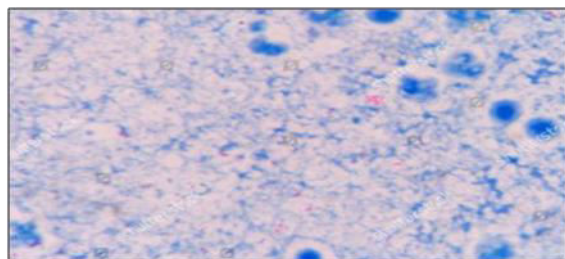
### **Risk factors for Drug Resistant Tuberculosis**

MDR-TB was defined as resistance to the first-line TB drugs Amikacin and Isoniazid, with or without resistance to other first-line TB drugs (Manaf AIMatar *et al.*, 2017). Microbiological verification was needed to confirm resistance type of the patients (Manaf AIMatar *et al.*, 2017).

**Figure.1** Ziehl–Neelsen stain for *M.tuberculosis*



**Figure.2** AFB Stain for *M.tuberculosis*



## Outcomes of Tuberculosis

The treatment outcome is a crucial indicator of the effectiveness of tuberculosis treatment programs (Manaf AlMatar *et al.*, 2017). Assessing the current treatment outcome and its associated factors is essential for improving patient care and reducing the spread of tuberculosis (Manaf AlMatar *et al.*, 2017). Therefore, this study aimed to assess Tuberculosis treatment outcomes and their associated factors among Tuberculosis patients who received treatment at public healthcare facilities in India (Schluger *et al.*, 1997). India accounts for about 25% of global Tuberculosis burden, with an estimated tuberculosis incidence of 2.77 million in 2022 (Barberis *et al.*, 2017). The estimated incidence of tuberculosis in 2023 increased slightly to 27.8 lakh (Barberis *et al.*, 2017).

## Control program of tuberculosis

Government of India is producing lot of efforts to bring down the challenges associated with tuberculosis through (Sanyaolu *et al.*, 2019). In malignance of this, there's a long way to go to achieve significant deduction in high occurrence and prevalence of tuberculosis in India (Sanyaolu *et al.*, 2019). Factors like lack of awareness and resources, poor infrastructure, increasing medicinal resistant cases, poor advertisement and overall

carelessness are the considerable challenges (James *et al.*, 2016). However, educate the millions and eliminate the stigma attached with tuberculosis, we can hope for a complaint free future. If we eradicate poverty and undernourishment (James *et al.*, 2016). Poor socioeconomic status and living conditions are considered as strong threat factors linked with idle Tuberculosis Infection in addition to malnourishment. BCG is the vaccine commonly accessible against tuberculosis (James *et al.*, 2016). It does offer some shield against serious forms of tuberculosis in nonage but its protective effect wanes with age (James *et al.*, 2016). Idle tuberculosis is also getting a significant issue in ageing population (James *et al.*, 2016). According to the experts, the tuberculosis eradication programme of administration has failed because of inadequate budgetary allotment to the programs, lack of proper structure and force and poor implementation of programs (Thomas R. Frieden, 2002). The various programs of the administration fail to address the root cause of the problem (Thomas R. Frieden, 2002). Also, the corruption in the healthcare system is hindering the policies from reaching the population (Thomas R. Frieden, 2002). The National TB Control Programme was started in 1962 with the aim to detect cases earliest and treats them (Alexander Muacevic *et al.*, 2023). In the district, the programme is implemented through the district Tuberculosis Centre (DTC) and the Primary Health Institutions (Alexander Muacevic *et al.*, 2023). The

Revised National Tuberculosis Control Programme (RNTCP), based on the Directly Observed Treatment, Short Course (DOTS) strategy, began as a pilot project in 1993 and was launched as a national programme in 1997 but rapid RNTCP expansion began in late 1998 (Alexander Muacevic *et al.*, 2023). The nation-wide coverage was achieved in 2006. RNTCP's National Strategic Plan (NSP) 2012-17 was part of the country's 12th Five year Plan with a target of "reaching the unreached" (Alexander Muacevic *et al.*, 2023). The NSP 2017 - 2025 builds on the success and learning's of the last NSP and encapsulates the bold and innovative steps required to eliminate Tuberculosis in India by 2030 (Thomas R. Frieden, 2002). It is crafted in line with other health sector strategies and global efforts, such as the draft National Health Policy 2015, World Health Organization's (WHO) End TB Strategy (Thomas R. Frieden, 2002). The Ministry of Health and Family Welfare, Government of India (MoHFW) along with various development partners of the Health Ministry launched the Tuberculosis TB Mukta Bharat Abhiyaan in 2021 under the NSP India 2020–25 for TB Elimination in a major mission activity for ending the epidemic of TB by 2025 (Thomas R. Frieden, 2002).

Although is a life threatening disease, with early diagnosis and proper medication, it can be cured (Sanyaolu *et al.*, 2019). The bacteria can travel through the air and spread from one person to the next (Jane *et al.*, 2023). This happens when infected people cough, sneeze, or spit (Schluger *et al.*, 1997). Tuberculosis can be controlled if appropriate policies are followed, effective clinical and public health management is ensured, and there are committed and co-ordinate efforts from within and outside the health sector (Schluger *et al.*, 1997). Tuberculosis generally affects the lungs, but it can also affect other parts of the body (James *et al.*, 2016). Most infections show no symptoms, in which case it is known as latent tuberculosis (James *et al.*, 2016). Around 10% of latent infections progress to active disease which, if left untreated, kill about half of those affected (James *et al.*, 2016).

### Author Contributions

Mohit Kumar: Investigation, formal analysis, writing—original draft. Dolly Rastogi: Validation, methodology, writing—reviewing. Mansi Singh:—Formal analysis, writing—review and editing. Ujjwal Agnihotri: Investigation, writing—reviewing. Sonam Singh: Resources, investigation writing—reviewing. Yashvi

Gupta: Validation, formal analysis, writing—reviewing. Tushar Sharma: Conceptualization, methodology, data curation, supervision, writing—reviewing the final version of the manuscript. Munish Rastogi: Investigation, formal analysis, writing—original draft.

### Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

### Declarations

**Ethical Approval** Not applicable.

**Consent to Participate** Not applicable.

**Consent to Publish** Not applicable.

**Conflict of Interest** The authors declare no competing interests.

### References

- Alexander Muacevic and John R Adler, Shraddha Malwe, Dushyant Waviskar and Vasant Wagh, (2023). Tuberculosis and the Effectiveness of the Revised National Tuberculosis Control Program (RNTCP) to Control Tuberculosis: A Narrative Review. Volume-15(12):e51418. <https://doi.org/10.7759/cureus.51418>
- Barberis, I., N. L. Bragazzi, L. Galluzzo and M. Martini. The history of tuberculosis: from the first historical records to the isolation of Koch's bacillus. PMID: PMC5432783, PMID: 28515626, Volume,58(1),PubMedCentral.2017, Mar, PagesE9–E12.
- Gursimrat K Sandhu, Tuberculosis: Current Situation, Challenges and Overview of its Control Programs in India. Journal p global infectious diseases in India. Journal of Global Infectious Diseases. Vol-3 Issue-2. Apr-Jun 2011,143-150. <https://doi.org/10.4103/0974-777X.81691>
- James J. Dunn, Jeffrey R. Starkez, Paula A. Revell, Laboratory Diagnosis of *Mycobacterium tuberculosis* Infection and Disease in Children. Journal in clinical microbiology, ASM Journals. Journal of Clinical Microbiology, Vol. 54, No. 6 23 May,2016.

- <https://doi.org/10.1128/JCM.03043-15>  
Jane S. Afriyie-Mensah, Robert Aryee, Francisca Zigah, Ernest Amaning-Kwarteng, and Marie Nancy Séraphin, (2023). The Burden of Bacteriologically Negative TB Diagnosis: A Four-Year Review of Tuberculosis Cases at a Tertiary Facility. Department of Medicine and Therapeutics, University of Ghana Medical School, University of Ghana, Accra, Ghana.: Journal: Tuberculosis Research and Treatment. 23 December, 2023.  
<https://doi.org/10.1155/2023/6648137>
- Manaf AlMatar, Husam AlMandea,İşıl Var, Begüm Kayar, Fatih Köksal.New drugs for the treatment of *Mycobacterium tuberculosis* infection Author links open overlay panel. Biomedicine & Pharmacotherapy, Journal of ELSEVIER. 91:546-558.  
<https://doi.org/10.1016/j.biopha.2017.04.105>.
- Matteo Zignol, A Wayne van Gemert, A, Dennis Falzon, A, Charalambos Sismanidis, A, Philippe Glaziou, A, Katherine Floyd & Mario Raviglionea, Surveillance of anti-tuberculosis drug resistance in the world: an updated analysis,. Bull World Health Organization. 2012 Feb 1; 90(2):. Published online: 2011 Nov7.  
<https://doi.org/10.2471/BLT.11.092585>, 2007–2010, 111–119D.
- Sanyaolu, Schwartz, Roberts, Evora, Dhoother *et al.*, Tuberculosis: A Review of Current Trends, June 2019. Epidemiology International Journal., 3(2):000123 <https://doi.org/10.23880/ej-16000123>,
- Schluger, N. W., R. Huberman, N. Wolinsky, R. Dooley, W. N Rom, R. S Holzman. Tuberculosis infection and disease among persons seeking social services in New York City, International Journal of Tuberculosis & Lungs Diseases. Volume(1): 1997, Feb;1.Pages 31-37.
- Thomas R Frieden, Issue 5, Can tuberculosis be controlled? *International Journal of Epidemiology*, 2002, October. Pages 894–899.  
<https://doi.org/10.1093/ije/31.5.894>

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