WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
Coden USA: WJPRAP Impact Factor 8.63
Volume 15, Issue 12, 267-283. Review Article ISSN 2277–7105

A REVIEW ON TUBERCULOSIS IN INDIA CONTROL, CASE STUDY AND CHALLENGES STRATEGIES

Sagar Singh Jough[1], Riya Mathur[2]*

[1]Associate Professor, Axis Institute of Pharmacy, Kanpur, Uttar Pradesh, India.

[2]Assistant Professor, Axis Institute of Pharmacy, Kanpur, Uttar Pradesh, India.

Article Received on 15 May 2026,
Article Revised on 05 June 2026,
Article Published on 16 June 2026,

https://doi.org/10.5281/zenodo.20695738

***Corresponding Author**

Riya Mathur

Assistant Professor, Axis Institute of Pharmacy, Kanpur, Uttar Pradesh, India.

How to cite this Article: Sagar Singh Jough1, Riya Mathur2*. (2026). A Review on Tuberculosis In India Control, Case Study And Challenges Strategies. World Journal of Pharmaceutical Research, 15(12), 267–283.

ABSTRACT

Tuberculosis is a severe infectious disease caused by the agent mycobacterium tuberculosis. It usually affects the lungs but can affect any part of the body. It is a global health concern affecting millions of people around the world. Despite having effective treatments and programs for its eradication, it remains one of the most stubborn challeng. Signs of TB include persistent cough, weight loss, fever and chills. Pharmacovigilance refers to the process of monitoring the safety and efficacy of drugs in order to detect and prevent any risk related to their use. It is an essential process for ensuring patient safety and preventing any harm from the use of medicine. Adverse Drug Reactions (ADRs) are the noxious effects which can occur with the use of medication and Pharmacovigilance is an essential practice in order to detect these ADRs and manage hem according to the guidelines laid out by the regulatory agencies. ADRs in the treatment of TB, be it Primary TB or MDR or XDR-TB are a common occurrence more so in the case of MDR and XDR-TB as the second line drugs used in the treatment of TB have a high toxicity profile. The most common ADR associated with use of anti-tubercular drugs is gastrointestinal problems including nausea, vomiting and gastrointestinal irritation. Other ADRs such as psychosis, hepatootxicity, peripheral neuropathy, Ototoxicity, vision problems, Arthralgia and skin reactions are also observed with the patients undergoing treatment for TB. Management of ADRs is one of the most essential step as proper management can improve the condition of the patient quickly and with affective management the ADRs associated with the use of anti-tubercular drugs can be

significantly.

KEYWORDS: Tuberculosis, Mycobacterium tuberculosis, Pharmacovigilance, Adverse Drug Reactions.

INTRODUCTION

Tuberculosis (TB) is a highly infectious airborne disease caused by the bacterium Mycobacterium tuberculosis (M. tuberculosis). M. tuberculosis and seven very closely related mycobacterial species (M. bovis, M. africanum, M. microti, M. caprae, M. pinnipedii, M. canetti and M. mungi) together comprise what is known as the M. tuberculosis complex. Most, but not all, of these species have been found to cause disease in humans. In the United States, the majority of TB cases are caused by M. tuberculosis. M. tuberculosis organisms are also called tubercle bacilli.[1]

Figure 1: **Mycobacterium Tuberculosis.**

It primarily affects the lungs, but can also target other parts of the body, such as the kidneys, spine, and brain. TB is a major global health issue, with an estimated 10 million people falling ill and 1.4 million dying from the disease in 2019 alone. It is also one of the top 10 causes of death worldwide and the leading cause of death from a single infectious agent, according to the World Health Organization (WHO).[2] Despite the availability of effective treatments, TB remains a significant global health challenge, particularly in low- and middle-income countries. Factors contributing to the ongoing burden of TB include poverty, malnutrition, weakened immune systems, and inadequate access to healthcare and TB medications. The emergence of drug-resistant strains of TB also presents a significant challenge to TB control efforts. There have been significant advances in the diagnosis and treatment of TB in recent years, including the development of new diagnostic tests and drug

regimens. However, ongoing efforts are needed to improve access to these interventions and to address the underlying social determinants of TB, such as poverty and lack of education.[3]

Epidemiology of Tuberculosis

Tuberculosis (TB) is a global public health problem, with an estimated 10 million cases and 1.4 million deaths in 2019. TB is most prevalent in low-income and middle-income countries. TB is primarily spread through the air when an infected person coughs, sneezes, or talks. TB is not spread through casual contact, such as shaking hands or sharing food or drinks. TB is more likely to be transmitted in overcrowded, poorly ventilated settings, such as prisons, hospitals, and homeless shelters.[4] Factors contributing to the persistence of TB include poverty, malnutrition, crowded living conditions, inadequate healthcare systems, and a lack of access to diagnostics, drugs, and vaccines. Additionally, the emergence of drug-resistant TB poses a significant threat to TB control efforts, particularly in low-income and middle-income countries.[5,6]

Factors affecting Tuberculosis

Tuberculosis (TB) is a complex disease that is influenced by a variety of factors, including host, environmental, and pathogen-related factors. Some of the key factors that can increase the risk of TB include.[7-10]

1. **HIV infection**: People living with HIV are at a higher risk of developing TB due to weakened immune systems.
2. **Malnutrition**: Poor nutrition can weaken the immune system and increase the risk of developing TB.
3. **Diabetes**: Diabetes is a known risk factor for TB, as it weakens the immune system and can lead to complications that increase the risk of developing TB.
4. **Smoking**: Tobacco smoking has been shown to increase the risk of developing TB and can worsen TB symptoms.
5. **Alcohol abuse**: Alcohol abuse can weaken the immune system and increase the risk of developing TB.
6. **Overcrowding and poor living conditions**: TB is more likely to be transmitted in overcrowded, poorly ventilated settings such as prisons, hospitals, and homeless shelters.
7. **Healthcare-related factors**: Poor infection control practices in healthcare settings can contribute to the spread of TB.
8. **Drug-resistant TB**: The emergence of drug-resistant TB poses a significant threat to TB

control efforts, particularly in low-income and middle-income countries.[7- 9]

Mode of Transmission

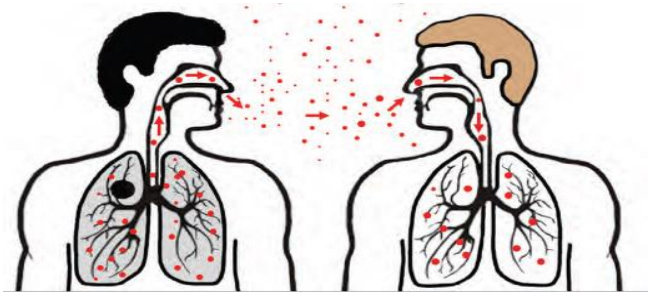

Figure 2: Airborne Transmission of Mycobacterium Tuberculosis.

Once inhaled, TB bacteria can settle in the lungs and begin to multiply, leading to the development of active TB disease. Active TB can then be transmitted to others through the air. However, not everyone who is infected with TB will develop active TB disease. In some cases, the immune system is able to control the infection, leading to latent TB infection. People with latent TB infection do not have symptoms and cannot spread TB to others, but they are at risk of developing active TB disease in the future if their immune system becomes weakened.[11]

Pathogenesis of Tuberculosis

Infection occurs when a person inhales droplet nuclei containing tubercle bacilli that reach the alveoli of the lungs. These tubercle bacilli are ingested by alveolar macrophages; the majority of these bacilli are destroyed or inhibited. A small number may multiply intracellularly and are released when the macrophages die. If alive, these bacilli may spread by way of lymphatic channels or through the bloodstream to more distant tissues and organs (including areas of the body in which TB disease is most likely to develop: regional lymph nodes, apex of the lung, kidneys, brain, and bone). This process of dissemination primes the immune system for a systemic response.[12]

Signs and Symptoms of Tuberculosis

Tuberculosis (TB) can affect any part of the body, but it most commonly affects the lungs. The signs and symptoms of TB can vary depending on the type of TB and the part of the body that is affected. The most common symptoms of pulmonary TB include:[13-21]

1. Persistent cough that lasts for more than three weeks.
2. Chest pain.

3. Coughing up blood.
4. Fatigue.
5. Fever.
6. Night sweats.
7. Loss of appetite.
8. Weight loss.

Diagnostic Tests of TB

1. Sputum smear microscopy as a test for TB

Smear microscopy of sputum is often the first test to be used in countries with a high rate of TB infection. Sputum is a thick fluid that is produced in the lungs and the airways leading to the lungs. A sample of sputum is usually collected by the person coughing. Several samples of sputum will normally be collected. In 2012 it was suggested that two specimens can be collected on the same day without any loss of accuracy.[22,23] To do the test a very thin layer of the sample is placed on a glass slide, and this is called a smear. A series of special stains are then applied to the sample, and the stained slide is examined under a microscope for signs of the TB bacteria. Sputum smear microscopy is inexpensive and simple, and people can be trained to do it relatively quickly and easily. In addition the results are available within hours. The sensitivity though is only about 50-60%. In countries with a high prevalence of both pulmonary TB and HIV infection, the detection rate can be even lower, as many people with HIV and TB co- infection have very low levels of TB bacteria in their sputum, and are therefore recorded as sputum negative.[24-32]

2. Fluorescent Microscopy

The use of fluorescent microscopy is a way of making sputum tests more accurate. With a fluorescent microscope the smear is illuminated with a quartz halogen or high pressure mercury vapour lamp, allowing a much larger area of the smear to be seen and resulting in more rapid examination of the specimen. One disadvantage though is that a mercury vapour lamp is xpensive and lasts a very short time. Such lamps also take a while to warm up, they burn significant amounts of electricity, and electricity supply problems can significantly shorten their life span. One way of overcoming these problems is the use of light emitting diodes (LEDs). Th se switch on extremely quickly, have an extremely long life, and they don’t explode.

In 2011 the World Health Organisation issued a policy statement recommending that con

entional fluorescence microscopy should be replaced by LED microscopy. It also recommended that in a phased way, that LED microscopy should replace conventional Ziehl-Neelsen light microscopy.[33]

3. Chest X-ray

If a person has had TB bacteria which have caused inflammation in the lungs, an abnormal shadow may be visible on a chest x-ray. 12 Also, acute pulmonary TB can be easily seen on an X-ray. However, what it shows is not specific. A normal chest X-ray cannot exclude extra pulmonary TB.

4. TB Interferon gamma release assays (IGRAs)

The Interferon Gamma Release Assays (IGRAs) are a new type of more accurate test. In this context referring to an assay is simply a way of referring to a test or procedure. IGRAs are blood tests that measure a person's immune response to the bacteria that cause TB. The immune system produces some special molecules called cytokines. These TB tests work by detecting a cytokine called the interferon gamma cytokine. In practice you carry out one of these TB tests by taking a bloo sample and mixing it with special substances to identify if the cytokine is present. Two IGRAs that have been approved by the U.S. Food and Drug Administration (FDA), and are commercially available in the U.S., are the QuantiFERON® TB Gold test, and the T- SPOT® TB test.

The advantages of an IGRA include the fact that it only requires a single patient visit to carry out the TB test. Results can be available within 24 hours, and prior BCG vaccination does not ause a false positive result. Disadvantages include the fact that the blood sample must be processed fairly quickly, laboratory facilities are required, and the test is only for latent TB. It is also thought that the IGRAs may not be as accurate in people who have HIV. In low prevalence resource rich settings, IGRAs are beginning to be used in place of the TB skin test.

5. Serological tests as a test for TB

Serological tests are carried out on samples of blood, and they claim to be able to diagnose TB by detecting antibodies in the blood. However, testing for TB by looking for antibodies in the blood is very difficult. As a result serological TB tests, sometimes called serodiagnostic tests, are inaccurate and unreliable. The World Health Organisation has warned that these tests should not be used to try and diagnose active TB. Some countries have banned the use

of serological or serodiagnostic tests for TB. Serological tests for TB are very different from the IGRA tests described above.[34.35]

6. Molecular tests

Some new molecular tests such as the Genexpert test and the TrueNat test are now available. The TrueNat was approved by the World Health Organisation (WHO) in 2020. The WHO has produced guidelines on the use of different tests.

7. Tests for TB summary

There is no single test that can be used to test for TB in all circumstances. Some tests are cheap but not very accurate. Some can only be used to test for TB and cannot test for drug resistance. Others such as the TB culture test, the new Genexpert and the TrueNat group of tests can be used to diagnose TB and they can also test for some types of TB drug resistance.

Anti-Tuberculosis Drugs

First Line

- Rifampin
- Isoniazid
- Pyrazinamide
- Ethambutol

Second Line

- Kanamycin (discontinued use in the USA)
- Streptomycin
- Capreomycin
- Amikacin
- Levofloxacin
- Moxifloxacin
- Gatifloxacin

MDR-TB

- Bedaquiline
- Delamanid
- Linezolid
- Pretomanid

Treatment of Tuberculosis

Tuberculosis (TB) is a treatable and curable disease, but treatment requires a combination of drugs that must be taken for several months. The drugs used to treat TB are called anti-TB drugs and they work by killing the bacteria that cause TB. The most commonly used anti-TB drugs include:[36]

1. Isoniazid (INH)
2. Rifampin (RIF)
3. Ethambutol (EMB)
4. Pyrazinamide (PZA)

Prevention and Control of Tuberculosis

Prevention and control of tuberculosis (TB) involves a combination of measures aimed at reducing the incidence and spread of the disease. The World Health Organization (WHO) has developed a comprehensive strategy for TB prevention and control, known as the End TB Strategy, which aims to reduce TB deaths by 90% and TB incidence by 80% by 2030. (11) Some key measures for TB prevention and control include:[37-43]

1. **Vaccination**: The BCG vaccine is a widely used vaccine for TB prevention, particularly in children. While the BCG vaccine is not 100% effective in preventing TB, it can reduce the risk of severe forms of TB, such as TB meningitis and disseminated TB.
2. **Early diagnosis and treatment**: Early detection and treatment of TB can prevent the spread o the disease and improve outcomes for patients. This involves screening for TB in high-risk populations, such as those living in areas with high TB incidence or those with HIV, and providing prompt diagnosis and treatment to those who test positive.
3. **Infection control**: TB is primarily spread through the air when an infected person coughs or sneezes. Infection control measures, such as good ventilation, isolation of patients with infectious TB, and use of masks by healthcare workers, can help prevent the spread of TB.
4. **Addressing social determinants of TB**: Poverty, malnutrition, and overcrowding are all risk factors for TB. Addressing these social determinants of TB, such as through improved housing, access to education, and poverty reduction programs, can help reduce the incidence of TB.
5. **Treatment of latent TB infection**: Some individuals may have latent TB infection, which means they have been infected with TB bacteria but do not have active TB disease. Treating latent TB infection can prevent the development of active TB disease in these

individuals.

6. **Collaboration between healthcare sectors**: TB prevention and control requires collaboration between healthcare providers, public health officials, and community organizations. This may involve initiatives to increase awareness of TB, improve access to healthcare, and strengthen healthcare systems.

Pharmacovigilance

Pharmacovigilance is the practice of monitoring the safety and efficacy of drugs in order to identify and mitigate potential risks associated with their use. The World Health Organization (WHO) defines pharmacovigilance as "the science and activities related to the detection, assessment, understanding, and prevention of adverse effects or any other drug-related problem."[44]

The process of pharmacovigilance involves the collection and analysis of data from a variety of sources, including spontaneous reports from healthcare professionals and patients, clinical trials, and epidemiological studies. This data is then used to identify and evaluate potential safety con erns associated with drugs, which may result in changes to drug labeling, restrictions on use, or even withdrawal from the market.

In recent years, the importance of pharmacovigilance has been highlighted by several high-prof le drug safety controversies, such as the Vioxx scandal in 2004, which led to the withdrawal of a popular painkiller from the market due to concerns over increased risk of heart attacks and strokes.

Overall, pharmacovigilance plays a critical role in ensuring the safety of medication use, and is essential for protecting public health. As new drugs continue to be developed and introduced, it will be increasingly important to prioritize and invest in pharmacovigilance nefforts to ensure that patients receive safe and effective treatments.

Review of Adverse Drug Reactions and Management during treatment of Tuberculosis

Study 1: Tak d k, acharya l d, gowrinath k,rao padma g m, subish P.safety evaluation of antitubercular therapy under revised National tuberculosis control programme in india. Journal of Clinical and Diagnostic Research 2009 April; 3:1395-1401.[45]

Sample Size

A total of 94 patients suffering from Tuberculosis were chosen for this study. All these

patients were on DOTS therapy.

RESULTS

Out of 94 patients, 16 patients developed 21 ADRs with an overall incidence of 17.02%. Among the 16 patients, 11(69%) developed only one ADR and 5 (31%) developed two ADRs each. Among 21 reported ADRs, the highest numbers of ADRs [20 (95%)] were observed in males and the remaining 1 (5%) was observed in a female. Out of 21 ADRs, 9 (42.85%) each, were observed in the age group of 18-40 years and 41-60 years. Three (14.28%) ADRs were observed in the age group of 61 and above. Below is a table showing the various ADRs reported among the patients.

Types of ADRs	No.
Gastritis	8
Hepatitis	2
Anorexia	1
Skin Reaction	3
Peripheral neuropathy	1
Dizziness	1
Psychosis	1
Ototoxicity	1
Vertigo	1
Weakness	1
Arthralgia	1

Management of ADRs

In 3 (14.28%) cases, the ADRs were managed by withdrawing the suspected drugs. Out of these, in 2 (9.52%) cases, symptomatic treatment was given whereas in 1(4.76%) case, specific treatment was given. In 18 (85.71%) cases, the drug was continued in spite of the occurrence of ADRs. Out of these, in 9 (42.85%) cases, symptomatic treatment was given, whereas in 9 (42.85%) cases, no treatment was given. In none of the cases was the dose of the drug altered/reduced.[46]

Outcome of the ADR

In 13 (61.90%) cases, the patients recovered from ADRs without any complications and in 6(28.57%) cases, the reactions continued on discharge, while in 2 (9.52%) cases, the outcome was unknown as patients got discharged. There were no fatal reactions during the study period.[47,48]

Study 2: Dedun AR, Borisagar GB, Solanki RN. Impact of adverse drug reaction of first line Anti – tuberculous drugs on treatment outcome of tuberculosis under revised national Tuberculosis control programme. Int J Adv Med., 2017; 4: 645-9.

Sample Size

974 patients were screened for the purpose of this study.

Result

Out of 974 patients screened during the study period 72 (7.79%) had some or other adverse drug effects. Occurrence of ADRs was more in male patients (45, 63%) as compared to females (27, 37%).Out of 72 patients developed ADRs, 49 (68%) were having pulmonary TB and rest 23 (32%) had extra-pulmonary TB. Prevalence of gastritis and jaundice was found to be highest, which was around 1.64% and 1.74% respectively in this study. Skin hypersensitivity reaction due to anti-tubercular drug was also common adverse drug reaction encountered which was around 1.43%. Below is a table showing the various ADRs reported among the patients

Types of ADRs	No.
Gastritis	16
Jaundice	17
Ototoxicity	2
Skin problems	16
Peripheral neuropathy	6
Gout	6
Giddiness	7
Thrombocytopenia	1
Psychosis	1

Management of ADRs

Out of the 72 patients who developed adverse drug reactions, only 9 patients required complete stoppage of that offending agent, while 2 patients require interruption of treatment in whom, all the drug where started one by one in order of ethambutol, rifampicin, pyrizinamide, and isoniazid, and most of the patients (61) were managed with supportive medication without removing anti tubercular drug from their treatment regimen.

Conclusion of Study

The current incidence of side effects was 7.79%, in a total of 72 patients. The major severe side effects were gastric side effects, hepatotoxicity, ototoxicity, hyperuricemia and

neuropsychiatric manifestations.

Prevalence of ADRs in treatment of Primary TB

As the observation of the studies 1-4 which comprised of the patients suffering from Primary Tuberculosis(Non Drug Resistant Tuberculosis) the incidences of ADRs were found to be from 8% to 20%, which in some other studies have also gone to as high as 80%. The First Line Drugs are used in the treatment of Primary TB as part of the DOTS regimen. The occurrence of ADRs va ied because of various factors such as demographic patterns, biological factors, geographical factors, error in reporting of ADRs. The most commonly occurring ADRs were usually related to the Gastro Intestinal System with nausea, vomiting and GI irritation being the most prevalent.[49]

Prevalence of ADRs in treatment of MDR and XDR TB

The studies 5-8 included the patients suffering from Multi Drug Resistant Tuberculosis. The reporting and management of patients suffering from MDR TB can be very tricky as the treatment is quite long and tedious lasting from 12 months to anywhere near 36 months adding to that the complex nature of the second line drugs and the drugs used for MDR TB.

Th incidence of ADRs ranged from 14% to 60% which can go as high as 90-95% in some studies. This is majorly due to the long duration of the treatment and the high toxicity profile of the drugs involved in the treatment. Almost all the patients develop ADRs associated with the GI system and also ADRs related to the Central Nervous System can be observed on a regular basis.

Management of ADRs

Management of ADRs associated with anti-tubercular drugs is considered to be an essential component in order to achieve adequate adherence leading to favorable outcome. Patients with MDR TB require special attention and care as the second line drugs are more toxic. Pri ciples of pharmacovigilance have been adopted by national TB control programs all over the world. The objective is to improve patient care by assessing both risk and benefit received from the drug. Routine surveillance of ADRs; according to a framed protocol is an integral part of national programs which should be performed by symptom based reporting followed by laboratory investigations at baseline and as when clinically indicated. Monitoring should be frequent and more intense particularly in high risk groups such as elderly, HIV or hepatitis coinfection, alcoholism, drug addiction, anemia, any preexisting illnesses, diabetes mellitus,

hypoalbuminemia, malnutrition, chronic kidney disease, chronic liver disease, disseminated involvement, family history of frequent ADRs; or atopy/allergy and use of ancillary medications, antiretroviral therapy or medications for treating opportunistic infections with high probability of drug interactions.

CONCLUSION

Tuberculosis is one of the major infectious diseases and it affects the lives of millions in the world. The treatment of TB is pretty straight forward and very well structured now-a-days. The DOTS therapy given the patients has been proven very affective and although MDR TB has been an obstacle newer discoveries and innovations in the field of diagnosis and treatment are being made every day in order to come up with better treatment plans and drugs with lesser side and adverse reactions. Adverse Drug Reactions in the treatment of TB has been prevalent due the high toxicity profile of the first line as well as the second line anti-tubercular drugs. The duration of the treatment can also be a challenge in the observation, reporting and the management of ADRs as the minimum duration of treatment of Primary pulmonary TB is 6 months, that of extra pulmonary TB is 9 months and the treatment of MDR and XDR TB can range between 12 to 36 months.[50-52]

In conclusion, Adverse Drug Reactions (ADRs) play a critical role in the treatment of tuberculosis (TB). While anti-TB medications are essential for the management and control of TB, they also carry the risk of ADRs, which can affect treatment outcomes and patient safety. This report has highlighted the different types of ADRs associated with anti-TB medications and their impact on treatment.

The findings from this report emphasize the need for healthcare professionals to be vigilant in monitoring patients for potential ADRs during TB treatment. They should also provide education to patients on the importance of adherence to medication, and encourage them to report any suspected ADRs promptly. Early detection and management of ADRs can help to minimize their impact on treatment and improve patient outcomes. Furthermore, this report underscores the importance of ongoing research and development of new and more effective anti-TB medications that have fewer adverse effects. This would improve treatment options and outcomes for TB patients, particularly those who are at higher risk of ADRs. Ultimately, by effectively managing ADRs in TB treatment, we can reduce the morbidity and mortality associated with this debilitating disease.

REFERENCES

1. CDC TB Manual, Chapter 2: Transmission and pathogenesis of tuberculosis, 21.
2. World Health Organization. (2020). Global tuberculosis report 2020. Geneva: World Health Organization.
3. Centers for Disease Control and Prevention. (2016). Tuberculosis (TB). Retrieved from https://www.cdc.gov/tb/default.htm
4. Pai, M., Behr, M. A., Dowdy, D., Dheda, K., Divangahi, M., Boehme, C. C.& Raviglione, M. Tuberculosis, 2016; 2: 16076.
5. United Nations. (2018). The Sustainable Development Goals Report 2018. Retrieved from https://unstats.un.org/sdgs/report/2018/
6. Uplekar M, Weil D, Lonnroth K, et al. WHO's new end TB strategy. Lancet, 2015; 385(9979): 1799-1801.
7. World Health Organization. Tuberculosis: Key facts. Available at: https://www.who.int/news-room/fact-sheets/detail/tuberculosis.
8. Nahid P, Dorman SE, Alipanah N, et al. Official American Thoracic Society/Centers for Disease Control and Prevention/Infectious Diseases Society of America Clinical, 2016; 63(7): e147-e195.
9. World Health Organization. Guidelines for the programmatic management of drug-resistant tuberculosis, 2011 update.
10. World Health Organization. Global tuberculosis report 2021. tuberculosis-report, 2021.
11. World Health Organization. The End TB Strategy.
12. CDC TB Manual, Chapter 2: Transmission and Pathogenesis of Tuberculosis, 26-27.
13. World Health Organization. Guidelines on the management of latent tuberculosis infection.
14. World Health Organization. Global Tuberculosis Report 2018. Geneva: WHO, 2018; 2018.
15. World Health Organization. Requirements for Adverse Reaction Reporting. Geneva, Switzerland: World Health Organization, 1975.
16. Shinde KM, Pore SM, Bapat TR. Adverse reactions to first-line anti-tuberculous agents in hospitalised patients: pattern, causality, severity and risk factors. Indian J Med Specialities, 2013; 4: 1e4.
17. Lv X, Tang S, Xia Y, et al. Adverse reactions due to directly observed treatment strategy therapy in Chinese tuberculosis patients: a prospective study. PLoS One., 2013; 8: e65037.

18. Anand AC, Seth AK, Paul M, Puri P. Risk factors of hepatotoxicity during anti-tuberculosis treatment. MJAFI (Med J Armed Forces India), 2006; 62: 45e49.
19. Parthasarathy R, Sarma GR, Janardhanam B, et al. Hepatictoxicity in south Indianpatientsduring treatment of tuberculosis with short-course regimens containingisoniazid, rifampicin and pyrazinamide. Tubercle, 1986; 67: 99e108.
20. Purohit SD, Gupta PR, Sharma TN, Gupta DN, Chawla MP. Rifampicin and hepatic toxicity. Indian J Tuberc, 1983; 30: 107e109.
21. Blumberg HM, Burman WJ, Chaisson RE, et al. American thoracic society/centers for disease control and prevention/infectious diseases society of America: treatment of tuberculosis. Am J Respir Crit Care Med., 2003; 167: 603e662.
22. Steele MA, Burk RF, Desprez RM. Hepatitis with isoniazid and rifampicin e a meta-analysis. Chest., 1971; 99: 465e471.
23. Chhetri AK, Saha A, Verma SC, Palaian S, Mishra P, Shankar PR. A study of adverse drug reactions caused by first line anti-tubercular drugs used in Directly Observed Treatment, Short course (DOTS) therapy in western Nepal, Pokharan. J Pak Med Assoc., 2008; 58: 531e536.
24. Koju D, Rao BS, Shrestha B, Shakya R, Makaju R. Occurrence of side effects from anti-tuberculosis drugs in urban Nepalese population under DOTS treatment. Kathmandu Univ J Sci Eng Technol, 2005; 1.
25. Girling DJ. Adverse effects of anti-tuberculosis drugs. Drugs, 1982; 23: 56e74.
26. Philadelphia Tuberculosis Control Program. Guidelines for the Management of Adverse Drug Effects of Anti-mycobacterial Agents. Philadelphia: Lawrence Flick Memorial Tuberculosis Clinic, Philadelphia Tuberculosis Control Program, 1998.
27. Prasad R, Garg R, Verma SK. Isoniazid- and ethambutol induced psychosis. Ann Thorac Med., 2008; 3: 149e151.
28. Cohn ML, Mandel W, Middlebrook G, Russell Jr WF. Serum isoniazid levels and catalase activities of tubercle bacilli from isoniazid-treated patients. Am J Med Sci., 1957; 233: 66e68.
29. Jackson SL. Psychosis due to isoniazid. Br Med J., 1957; 28: 743e745. Carr RE, Henkind P. Ocular manifestations of ethambutol. Arch Ophthalmol, 1962; 67: 566e571.
30. Tsai RK, Lee YH. Reversibility of ethambutol optic neuropathy. J Ocul Pharmacol Ther., 1997; 13: 473e477.
31. Leibold JE. The ocular toxicity of ethambutol and its relation to dose. Ann N Y Acad Sci., 1966; 135: 904e909.

32. Citron KM, Thomas GO. Ocular toxicity from ethambutol (editorial). Thorax, 1986; 41: 737e739.
33. Tang S, Yao L, Hao X, et al. Efficacy, safety and tolerability of linezolid for the treatment of XDR-TB: a study in China. Eur Respir J., 2015; 45: 161e170.
34. Moore RE, Smith CR, Lietman PS. Risk factors for the development of auditory toxicity in patients receiving aminoglycosides. J Infect Dis., 1984; 149: 23e30.
35. Prrazic M, Saiaj B. Ototoxicity in children caused by streptomycin. Audiology, 1975; 14: 173e176.
36. Robinson GL, Cambon KG. Hearing loss in infants of tuberculous mothers treated with streptomycin during pregnancy. N Engl J Med., 1964; 271: 949e951.
37. Johnsonbaugh RE, Drexler HG, Light JJ, Sutherland JM.Familial occurrence of drug induced hearing loss. Am J Dis Child., 1974; 127: 245e247.
38. Indian Council of Medical Research Centre Report. Study of Chemotherapy regimens of 5 and 7 months duration and the role of corticosteroids in the treatment of Sputum-positive patients with pulmonary tuberculosis in South India. Tubercle, 1983; 64: 73e91.
39. Berte SJ, Dimase JD, Christianson CS. Isoniazid, paraaminosalicylic acid and streptomycin intolerance in 1,744 patients. Am Rev Respir Dis., 1964; 90: 598e606.
40. Gerdan G, Nurullah A, Ucan ES, Bulac Kir S. Paradoxical increase inuricacid levelwithallopurinol use inpyrazinamideinduced hyperuricemia. Singap Med J., 2013; 54: e125ee128.
41. Gutman AB, Yu TF, Berger L. Renal function in gout. III.Estimation of tubular secretion and reabsorption of uric acid by use of pyrazinamide (pyrazinoic acid). Am J Med., 1969; 47: 575e592.
42. Postlethwaite AE, Bartel AG, Kelley WN. Hyperuricemia due to ethambutol. N Engl J Med., 1972; 286: 761e762.
43. Kang BH, Jo KW, Shim TS. Current status of fluoroquinolone use for treatment of tuberculosis in a tertiary care hospital in Korea. Tuberc Respir Dis (Seoul), 2017; 80: 143e152. https://doi.org/10.4046/trd.2017.80.2.143.
44. Diacon A, Pym A, Grobusch M, et al. Multidrug-resistant tuberculosis and culture conversion with bedaquiline. N Engl J Med., 2014; 371: 723e732.
45. Pym AS, Diacon AH, Tang SJ, et al. Bedaquiline in the treatment of multidrug- and extensively drug-resistant tuberculosis. Eur Respir J., 2016; 47: 564e574.
46. Tawanda G. Chemotherapy of Tuberculosis, mycobacterium Avium Complex Disease and Leprosy. Goodman and Gilman's the Pharmacological Basis of the

Therapeutics. 12th ed. McGraw Hill Med., 2011; 1559.

47. Vedove CD, Del Giglio M, Schena D, Girolomoni G. Druginduced lupus erythematosus. Arch Dermatol Res., 2009; 301: 99e105.
48. Potter JL, Capstick T, Ricketts WM, Whitehead N, Kon OM. A UK-based resource to support the monitoring and safe use of anti-tuberculosis drugs and second-line treatment of multidrug-resistant tuberculosis. TB Drug Monographs, 2015; 90e96.
49. Garg R, Mehra S, Prasad R. Isoniazid induced gynaecomastia: a case report. Indian J Tuberc, 2009; 56: 51e54.
50. Khan A, Agarwal R. Isoniazid related gynaecomastia: description of a case and systematic review of literature. Lung India, 2012; 29: 189e191.
51. Prasad R. Anaphylactic shock due to streptomycin sulphate. J Indian Med Assoc, 1989; 82: 254e255.
52. WHO. A Practical Handbook on the Pharmacovigilance of Medicines Used in the Treatment of Tuberculosis. Enhancing the Safety of the TB Patient. Geneva, Switzerland, 2012.
53.