BIBLIOGRAPHIC INFORMATION SYSTEM

Journal Full Title: Journal of Biomedical Research & Environmental Sciences

Journal NLM Abbreviation: J Biomed Res Environ Sci

Journal Website Link: <https://www.jelsciences.com>

Journal ISSN: 2766-2276

Category: Multidisciplinary

Subject Areas: Medicine Group, Biology Group, General, Environmental Sciences

Topics Summation: 128

Issue Regularity: Monthly

Review Process type: Double Blind

Time to Publication: 7-14 Days

Indexing catalog: [Visit here](#)

Publication fee catalog: [Visit here](#)

DOI: 10.37871 ([CrossRef](#))

Plagiarism detection software: [iThenticate](#)

Managing entity: USA

Language: English

Research work collecting capability: Worldwide

Organized by: [SciRes Literature LLC](#)

License: Open Access by Journal of Biomedical Research & Environmental Sciences is licensed under a Creative Commons Attribution 4.0 International License. Based on a work at SciRes Literature LLC.

Manuscript should be submitted in Word Document (.doc or .docx) through **Online Submission** form or can be mailed to support@jelsciences.com

Vision

Journal of Biomedical Research & Environmental Sciences main aim is to enhance the importance of science and technology to the scientific community and also to provide an equal opportunity to seek and share ideas to all our researchers and scientists without any barriers to develop their career and helping in their development of discovering the world.

RETROSPECTIVE COHORT STUDY

Pharmacotherapy of Different Tuberculosis Patients its Analysis and Outcomes: A Retrospective Cohort Study

Asim Shahzad^{1*}, Muhammad Farhad Anwar², Abrar Hussain Mian¹, Abdul Rehman³ and Matiullah¹

¹Department of Microbiology, Hazara University, Mansehra 21300, Pakistan

²Department of Pharmacy, Abasyn University, Peshawar 25000, Pakistan

³Department of Microbiology, Kohat University of Science and Technology (KUST), Kohat 26000, Pakistan

ABSTRACT

This study aim was to evaluate the prescribed therapies and to identify various drug-related problems as well as their causes in different TB patients admitted at the Pulmonology Department, Northwest General Hospital and Research Centre, Hayatabad, Peshawar, Pakistan. A 5-month retrospective study was conducted in which a total of 525 patients' medical records were collected using redesigned standard data collection proforma. Among them, 25 patients having incomplete medical records were excluded and the rest of 500 cases were involved and analyzed accordingly. In all these cases, the causative agent was *Mycobacterium tuberculosis*. Overall 14 drugs of 133 different therapeutic classes were used in which the most frequently prescribed drugs to these patients were Anti-Tuberculosis drugs (100%), Antibiotic (100%), Multivitamins (78%), GIT drugs (55%) and Antihistamines (55%) followed by other drugs listed in the present study. Out of 500 cases, a total of 179 (35.8%) patients were identified had Drug-related problems, among them 23 (4.6%) cases were in untreated condition, in 12 (2.4%) cases drugs without indication problems were found, in 43 (8.6%) cases there were adverse drug reactions problems noted, in 75 (15%) cases total drug interactions problems were identified, while in 26 (5.2%) cases polypharmacy problems were found. The prescribed pharmacotherapy in all 500 cases meets with the standard pharmacotherapy. However, the discrepancies observed in the present study were due to lack of proper knowledge about the pharmacology of the drugs, overburden on doctors and proper lack of patient counseling. To better understand the proper management and reduction of these problems other health care professionals and proper clinical pharmacists are required to cooperate for the sake of improving the outcomes of the pharmacotherapy.

*Corresponding author

Asim Shahzad, Department of Microbiology, Hazara University, Mansehra 21300, Pakistan

E-mail: asimshahzad260@gmail.com

DOI: 10.37871/jbres1363

Submitted: 09 November 2021

Accepted: 27 November 2021

Published: 29 November 2021

Copyright: © 2021 Shahzad A, et al. Distributed under Creative Commons CC-BY 4.0 ©

OPEN ACCESS

Keywords

- Pharmacotherapy
- Outcomes
- Drug-related problems
- Tuberculosis patients

INTRODUCTION

Tuberculosis is a potentially serious bacterial infectious disease caused by *Mycobacterium tuberculosis* that mainly affects human lungs which have important public health consequences throughout the globe [1]. People normally get the infection through the direct spread of tiny droplets (0.5 to 5.0 µm in diameter) released by active pulmonary TB patients into the air via coughs and sneezes, when the person inhales each one of these droplets it reaches to the alveoli, then he starts the establishment of TB infection with important clinical manifestations [2-5]. In developing countries, about 95% of individuals were infected from Tuberculosis (TB) which comprises about a third of the world's population. A recent survey reported by the World Health Organization stated that in 2016 around 10 million cases and 1.75 million deaths were caused due to *Mycobacterium tuberculosis* disease [6]. Approximately, 56% of people who belong to Asian countries such as India, Indonesia, China, the Philippines and Pakistan are suffered from TB [7].

MEDICINE GROUP

PULMONOLOGY | PHARMACOLOGY | EPIDEMIOLOGY

VOLUME: 2 ISSUE: 11 - NOVEMBER

How to cite this article: Shahzad A, Anwar MF, Mian AH, Rehman A, Matiullah. Pharmacotherapy of Different Tuberculosis Patients its Analysis and Outcomes: A Retrospective Cohort Study. J Biomed Res Environ Sci. 2021 Nov 29; 2(11): 1154-1158. doi: 10.37871/jbres1363, Article ID: JBRES1363, Available at: <https://www.jelsciences.com/articles/jbres1363.pdf>

Among other high-burden countries worldwide, Pakistan is in the fifth number which shares 61% of TB cases in the WHO Eastern Mediterranean Region [8,9]. According to the 2016 survey, there were about 356,390 new cases of TB reported in Pakistan of which 80% were pulmonary tuberculosis (PTB) cases, and 4% cases had known HIV infection as compared with the 2015 survey (323,856 cases) [10]. Though the mortality rates of TB disease in Pakistan are declined now which ranging from 34 to 23 cases per 100,000 population, however, this TB leads a significant role in causing disease in this country which ultimately highlights the importance of an effective TB control program [11]. The increase in drug-resistant strains of the emerged bacterium called Multidrug-Resistant (MDR) tuberculosis has become an important complication worldwide especially in the developing countries that make tuberculosis most vulnerable to human health [12]. In Pakistan, a survey was conducted on MDR-TB which indicated that there were 4.3% of the MDR-TB appraised in newly notified TB cases and 19.4% in retreatment TB cases. These cases are on the rise, however, data about the proper management and treatment outcomes of MDR-TB in Pakistan is very less [13]. The certain important factors which can increase the risk of TB disease, are the high incidence ratio of HIV/AIDS infection among individuals worldwide [14,15], Diabetes mellitus [16], Cigarette smoking [17], Malnutrition [18], Severe kidney disease [19] and certain cancers [20], because of the weakened immune system, thus the body cannot mount efficient defence mechanisms. For successful diagnosis of tuberculosis disease, various helpful diagnostic tests can be used, including medical imaging, Physical examination, Chest radiograph, Microbiology tests, Mantoux Tuberculin Skin Test (TST), Interferon-Gamma Release Assays (IGRAs) and Histopathology [21,22]. Tuberculosis disease can be fatal if not treated properly. Bacillus Calmette-Guerin (BCG) vaccine is used to prevent severe tuberculosis in children and it is not very effective in adults [23,24]. Adults are effectively treated with drugs in two different phases having an overall duration of 6 months using the recommended doses listed in the British National Formulary (BNF) such as An initial phase of 2 months using 4 regimens (isoniazid (INH), rifampicin, pyrazinamide and ethambutol) while second continuation phase of further 4 months using 2 regimens (isoniazid and rifampicin) given in combination in full sensitive cases [25-28]. The objectives of this study were to analyze pharmacotherapy provided in the hospital for its rationale, status of alternatives and outcomes. To identify various drug-related problems involving the medication therapy provided in the hospital and to analyze their management and impact of interventions as well as to report drug information/therapeutic consultation or patient education and counseling that were provided during rotations.

METHODS

Study area and duration

The present study was a type of retrospective cohort

study and was undertaken at the Pulmonology Department, Northwest General Hospital and Research Centre, Hayatabad, Peshawar, Pakistan for a duration of 5 months from January to May 2018. Northwest General Hospital and Research Centre (<https://www.nwgh.pk>) is located at the western gateway, Phase 5 Hayatabad, Peshawar, Khyber Pakhtunkhwa, Pakistan. This is one of the proudly established gifts of Alliance Healthcare (Private) Limited and consists of more than 504 beds to accommodate patients at a time. It is providing state of the art tertiary medical, healthcare and cutting-edge research facilities to the people of Northern Pakistan.

Study population

A total of 525 patients' case histories were collected, among them, 25 patients having incomplete medical records of TB treatment were excluded, while the rest of 500 different TB patients who had complete case histories were therefore included and evaluated accordingly. Patients belonged from different cities and were admitted to the Pulmonology Department, Northwest General Hospital and Research Centre, Hayatabad, Peshawar, Pakistan. The average stay of the patient at this hospital was from 5 to 6 days, while in severe conditions patients were kept for 6 to 15 days.

Ethical approval

Ethical clearance for data collection to conduct the study was obtained from the authorities of the Pulmonology Department, Northwest General Hospital and Research Centre, Hayatabad, Peshawar, Pakistan.

Data collection and analysis

In the present study, all 500 cases were evaluated by using predesigned standard patient data collection proforma that contained patient identification and demographics, chief complaints, history of present and past illness, physical examination record, clinical laboratory tests and complete medication record charts. Drug-Related Problems (DRPs) were recorded, as per Pharmaceutical Care Network Europe (PCNE) DRP classification V8.02. According to these standard protocols all TB patients' complete data histories were screened out for result analysis using the Microsoft Excel version (2010).

RESULTS AND DISCUSSIONS

The present study was conducted at Pulmonology Department, Northwest General Hospital and Research Centre, Hayatabad, Peshawar, Pakistan in which a total of 500 patients' case histories were studied out with tuberculosis disease. Among them, 350 (70%) were male while 150 (30%) were female patients (Table 1).

Regarding area-wise distribution, most of the patients were from Peshawar 95 (19%) and the rest of them came from the other parts of Pakistan such as Takht Bahi 60

Table 1: Demographic details of all TB patients.

Characteristics	Number of Patients	Total %
Male	350	70
Female	150	30
Total	500	100

(12%), Nowshera 65 (13%), Mardan 75 (15%), Swabi 75 (15%), Swat 65 (13%) and Kohat 65 (13%) who belonged to the poor hygienic environment (Table 2).

In the present study, most of the affected patients 225 (45%) were above 40 years of age. While least affected patients 25 (05%) were 01-20 years of age as shown in (Table 3).

These patients were known TB from prolong time and the main causes of hospitalization of these patients were to avoid the complications of TB and the existence of concurrent diseases side by sides such as Pleural Effusion (125; 25%), Hypertension (50; 10%), Hyperglycemia (25; 5%), Hepatic Encephalopathy (25; 5%) and Pneumothorax (25; 5%). The average stay of the patient in the hospital was from 5 to 6 days as shown in (Table 4). The prescribed tests specifically performed for the proper monitoring of the tuberculosis disease by all these 500 patients were sputum test, chest x-rays and HRCT, ESR.HB and CBC. All these tests were of great help in the successful diagnosis of TB disease in these patients.

In the present study, the treatment provided in the hospital was completely evaluated and then the analysis of the case histories was done according to standard protocols. A total of 14 drugs of 133 different therapeutic classes were prescribed to these patients in order of Anti-Tb drugs

(100%), Antibiotic (100%), Multivitamins (78%), GIT drugs (55%) and Antihistamines (55%) were in high ratio, other than these were NSAIDs (45%), Bronchodilators (35%), Diuretics (25%), Corticosteroids (10%), Antihypertensive (10%), Electrolytes (5%), Antimalarial (5%), Antifibrinolytic agent (5%) and Anticonvulsants (5%) (Table 5).

In this study, various drugs were used in combination with Anti TB drugs for the complete therapy of all 500 TB patients. Among them, mostly Ceftriaxone + Mefenamic acid of high ratio 100 (20%) were used with anti-tubercular drugs. Ceftriaxone was used for the management of chest infection while mefenamic acid was used for the management of fever which has drug interaction with ceftriaxone. After complete evaluation, it was found that the therapy provided in the hospital to all of these 500 TB patients was mostly based on an empirical approach. While no such culture sensitivity test base antibiotic selection criteria were followed, such as in the present study drug interaction as shown in table 6, in which Paracetamol was used in combination with Isoniazid (anti-TB drug) which is hepatotoxic cause hepatic dysfunction and other complications in patients if given without proper monitoring protocol and specialized knowledge.

Following Pharmaceutical Care Network Europe (PCNE) DRP classification V8.02, in our study, a total of 179 (35.8%) patients were identified had drug-related problems, while 321 (54.42%) of patients were without DRPs. Among the identified DRPs, 23 (4.6%) cases were in untreated condition, in 12 (2.4%) cases drugs without indication problems were found, in 43 (8.6%) cases there were adverse drug reactions problems noted, in 75 (15%) cases total drug interactions problems were identified while in 26 (5.2%) cases polypharmacy problems were found (Table 7). The occurrence of such problems was due to the lack of proper counseling of patients, improper management of medication and the partial involvement of clinical pharmacists in the patient care unit. The crucial role of the clinical pharmacist is to contribute properly with the physician in the healthcare system and to intervene and rationalize the drug therapy as well as ensure safe, appropriate and cost-effective use of

Table 2: Area wise distribution of all TB patients.

Area	Frequency	Total %
Takht Bhai	60	12
Nowshera	65	13
Peshawar	95	19
Mardan	75	15
Swabi	75	15
Swat	65	13
Kohat	65	13
Total	500	100

Table 3: Age-wise distribution of all TB patients.

Age of Patients (years)	Number of Patients	Total %
01-20	25	05
21-40	75	15
41-60	225	45
61-80	175	35
Total	500	100

Table 4: Main cause of hospitalization of all TB patients along with the concurrent diseases and its total percentage.

Main cause of Hospitalization			
Tuberculosis Disease	Concurrent Disease	Number of Patients	Total %
Pulmonary TB	None	200	40
Pulmonary TB	Pleural Effusion	125	25
Pulmonary TB	Hypertension	50	10
Pulmonary TB	Hyperglycemia	25	05
Peritoneal TB	None	50	10
Pulmonary TB	Hepatic Encephalopathy	25	05
Pulmonary TB	Pneumothorax	25	05
Total		500	100

Table 5: List of prescribed medications (therapeutic classes) and their individual percentage in all TB patients (n = 500).

S. No	Drugs Name	Therapeutic class	Frequency (N = 500)	Total %
01	Antitubercular drugs	Isoniazid+ Rifampicin+ Ethambutol + Pyrazinamide	500	100
02	Antibiotics	Ceftriaxone, Cefotaxime, Levofloxacin, Clarithromycin, Amoxicillin + Cloulonic acid and Moxifloxacin	500	100
03	Multi vitamins	VIT B6 (pyridoxine), VIT B12 (macobalamin) + Vit B1+ Vit B6, Vit-k and Folic acid + Vit	390	78
04	GIT drugs	Dimenhydrinate, Lactulose and Domperidone	275	55
05	Anti-histamine	Levocetirizine, Cyproheptadine hcl, Ranitidine and Famotidine	275	55
06	NSAIDs	Diclofenic, Mefenemic acid and Paracetamol	225	45
07	Bronchodilator	Aminophylline and Salbutamol	175	35
08	Diuretics	Furosemide and Furosemide + Spironlactone	125	25
09	Corticosteroids	Dexamethasone	50	10
10	Antihypertensive	Ramipril	50	10
11	Electrolytes	Dextrose water (5%)	25	5
12	Antimalarial	Quinine	25	5
13	Antifibrinolytic agent	Tranexamic acid	25	5
14	Anticonvulsants	Alprazolam	25	5

Table 6: Drug interaction of each drug in combination with Anti TB drugs in all TB patients (n = 500).

Drug interaction	Occurrence	Total %
Isoniazid + Paracetamol	25	05
Rifampicin + Ramipril	50	10
Dimenhydrinate + Alprazolam	25	05
Ceftriaxone + Mefenamic acid	100	20
Rifampicin + Aminophylline	25	15
Isoniazid + Quinine	25	05
Rifampicin + Quinine	25	05
Isoniazid + Dexamethasone	50	10
Rifampicin + Dexamethasone	50	10
Cyproheptadine + Alprazolam	25	05

Table 7: Types of Drug-related problems found during therapy of all TB patients (n = 500).

Types of DRPs	Frequency	Total %
Untreated condition	23	4.6
Drug without indications	12	2.4
Adverse drug reactions	43	8.6
Total drug interactions	75	15
Polypharmacy	26	5.2
Total	179	35.8

Keywords: 179 (35.8%) of patients had DRPs, while 321 (54.42%) were without DRPs.

medicines. However, its role in some hospitals particularly in Pakistan is noticeably ignored, deprived of giving any proper concentration and recognition [29]. Hence, an appropriate management protocol should need to be followed for the control of various drug-related problems to avoid any mishap that can lead to morbidity, mortality, prolonged hospitalization and cost maximization.

CONCLUSION

In the present study, many drugs-related problems were identified during the therapy of different TB patients. It was deeply observed that there was no proper counseling to educate the patient about the medication and no such proper calculation of doses (as pediatrics needs special precaution and monitoring). The numbers of hospitals in Pakistan are leaded by physicians who are experts in diagnosis, however sometimes overburden on them and proper lack of patient counselling can result in the lack of sufficient knowledge and management about the drugs, which often leads to drug-related problems (i.e. the topic of the current issue and lack of knowledge on the part of professional staff, and socioeconomic problems). To better understand the proper management and reduction of these problems and to optimize and rationalize the medication therapy other health care professionals and proper clinical pharmacists are required to cooperate for the sake of improving the outcomes of the pharmacotherapy in particular.

LIMITATIONS

In this study, information about the status of planned interventions to solve the identified DRPs was unknown, thus not clearly observed and obtained. This could be due to the partial involvement of clinical pharmacists in the direct healthcare unit and proper lack of patients counselling by physicians sides about the medication use. Another important issue is that, it is just a reported based data and was actually gathered and evaluated from the medical records of different TB patients, so we cannot specify the real quality of these medical records and causes of such DRPs. However, the data provided in this study is reliable and may be useful to devise proper approaches to minimize the risk of such problems.

RECOMMENDATIONS

We suggest further comprehensive longitudinal based study to figure out the vital role of the healthcare professionals while counseling patients and to identify the exact reasons behind the development of such problems.

ACKNOWLEDGEMENTS

We are greatly indebted to the Pulmonology Department, Northwest General Hospital and Research Centre, Hayatabad, Peshawar, Pakistan for their technical support and assistance in data collection.

References

1. Saqib SE, Ahmad MM, Amezcua-Prieto C, Virginia MR. Treatment Delay among Pulmonary Tuberculosis Patients within the Pakistan National Tuberculosis Control Program. *Am J Trop Med Hyg*. 2018 Jul;99(1):143-149. doi: 10.4269/ajtmh.18-0001. Epub 2018 May 10. PMID: 29761768; PMCID: PMC6085810.
2. Wani RL. Clinical manifestations of pulmonary and extra-pulmonary tuberculosis. *South Sudan Medical Journal*. 2013;6(3):52-6.
3. Kompala T, Shenoi SV, Friedland G. Transmission of tuberculosis in resource-limited settings. *Current HIV/AIDS Reports*. 2013 Sep 1;10(3):264-72.
4. Hoppe LE, Kettle R, Eisenhut M, Abubakar I; Guideline Development Group. Tuberculosis—diagnosis, management, prevention, and control: summary of updated NICE guidance. *BMJ*. 2016 Jan 13;352:h6747. doi: 10.1136/bmj.h6747. PMID: 26762607.
5. Rieder H. Air pollution, COVID-19, and tuberculosis interrelationship. *Indian J Tuberc*. 2020 Jul;67(3):281-283. doi: 10.1016/j.ijtb.2020.07.033. PMID: 32825853; PMCID: PMC7434498.
6. Ahmed AE, Yousif N, Elhassan M, Edriss AI, Mudassir Z. Diagnostic performance of ziehl-neelsen, fluorescent auramine O stains and Genexpert for the detection of mycobacterium tuberculosis. *IOSR Journal of Dental and Medical Sciences*. 2018 Feb;17(2): 49-55. <https://bit.ly/3D5l9cW>
7. Masood R, Muhammad IN, Ali SK, Mushtaque M, Siddiqui T, Khalid F, Ali A. Morbidity rate of drug-susceptible tuberculosis and its medico-economic impact. *African Journal of Pharmacy and Pharmacology*. 2020 Jul 31;14(6):156-62. doi: 10.5897/AJPP2020.5127
8. Zumla A, George A, Sharma V, Herbert RH; Baroness Masham of Ilton, Oxley A, Oliver M. The WHO 2014 global tuberculosis report—further to go. *Lancet Glob Health*. 2015 Jan;3(1):e10-2. doi: 10.1016/S2214-109X(14)70361-4. PMID: 25539957.
9. Haroon SM, Afzal MS. Latent tuberculosis infection screening in HCV patients: The necessity and guidelines for Pakistan. *Asian Pacific Journal of Tropical Disease*. 2017;7(4):237-238.
10. Atif M, Anwar Z, Fatima RK, Malik I, Asghar S, Scallion S. Analysis of tuberculosis treatment outcomes among pulmonary tuberculosis patients in Bahawalpur, Pakistan. *BMC Res Notes*. 2018 Jun 8;11(1):370. doi: 10.1186/s13104-018-3473-8. PMID: 29884241; PMCID: PMC5994136.
11. Afzal U, Yusuf A. The state of health in Pakistan: An overview. In the State of Health in Pakistan: An Overview" with Anam Yusuf, paper presented at the Ninth Annual Conference on Management of the Pakistan Economy, Lahore School of Economics. Paper published in the Lahore Journal of Economics: Special Edition. September 1, 2013.
12. Wright A, Zignol M. Anti-tuberculosis drug resistance in the world: fourth global report: the world health organization/international union against tuberculosis and lung

- disease (who/union) global project on anti-tuberculosis drug resistance surveillance, 2002-2007. World Health Organization. 2008.
13. Javaid A. Burden of MDR-TB and its control in Pakistan. *Pakistan Journal of Chest Medicine*. 2016 Feb 9;21(4):131-133.
 14. Pozniak AL, Coyne KM, Miller RF, Lipman MC, Freedman AR, Ormerod LP, Johnson MA, Collins S, Lucas SB; BHIVA Guidelines Subcommittee. British HIV Association guidelines for the treatment of TB/HIV coinfection 2011. *HIV Med*. 2011 Oct;12(9):517-24. doi: 10.1111/j.1468-1293.2011.00954.x. PMID: 21951595.
 15. Resende NH, Miranda SS, Ceccato MDGB, Haddad JPA, Reis AMM, Silva DID, Carvalho WDS. Drug therapy problems for patients with tuberculosis and HIV/AIDS at a reference hospital. Einstein (Sao Paulo). 2019 Aug 22;17(4):eAO4696. doi: 10.31744/einstein_journal/2019AO4696. PMID: 31460617; PMCID: PMC6706227.
 16. Dabhi PA, Thangakunam B, Gupta R, James P, Thomas N, Naik D, Christopher DJ. Screening for prevalence of current TB disease and latent TB infection in type 2 diabetes mellitus patients attending a diabetic clinic in an Indian tertiary care hospital. *PLoS One*. 2020 Jun 5;15(6):e0233385. doi: 10.1371/journal.pone.0233385. PMID: 32502176; PMCID: PMC7274437.
 17. Alavi-Naini R, Sharifi-Mood B, Metanat M. Association between tuberculosis and smoking. *Int J High Risk Behav Addict*. 2012 Summer;1(2):71-4. doi: 10.5812/ijhrba.5215. Epub 2012 Jul 25. PMID: 24971236; PMCID: PMC4070106.
 18. Jaganath D, Mupere E. Childhood tuberculosis and malnutrition. *J Infect Dis*. 2012 Dec 15;206(12):1809-15. doi: 10.1093/infdis/jis608. Epub 2012 Oct 2. PMID: 23033147; PMCID: PMC3502375.
 19. Shu CC, Hsu CL, Lee CY, Wang JY, Wu VC, Yang FJ, Wang JT, Yu CJ, Lee LN. Comparison of the Prevalence of Latent Tuberculosis Infection among Non-Dialysis Patients with Severe Chronic Kidney Disease, Patients Receiving Dialysis, and the Dialysis-Unit Staff: A Cross-Sectional Study. *PLoS One*. 2015 Apr 28;10(4):e0124104. doi: 10.1371/journal.pone.0124104. PMID: 25919813; PMCID: PMC4412816.
 20. Chan ED. Are there common threads in the susceptibility to cancer and tuberculosis? *J Thorac Dis*. 2020 May;12(5):1776-1780. doi: 10.21037/jtd.2020.03.114. PMID: 32642083; PMCID: PMC7330389.
 21. Konstantinos A. Testing for tuberculosis. *Australian Prescriber*. 2010;33(1):12-18. doi: 10.18773/austprescr.2010.005.
 22. Wei M, Yongjie Zhao, Zhuoyu Qian, Biao Yang, Xi J, Wei J, Tang B. Pneumonia caused by Mycobacterium tuberculosis. *Microbes Infect*. 2020 Jul-Aug;22(6-7):278-284. doi: 10.1016/j.micinf.2020.05.020. Epub 2020 Jun 16. PMID: 32561408; PMCID: PMC7297158.
 23. Trunz BB, Fine P, Dye C. Effect of BCG vaccination on childhood tuberculous meningitis and miliary tuberculosis worldwide: a meta-analysis and assessment of cost-effectiveness. *Lancet*. 2006 Apr 8;367(9517):1173-80. doi: 10.1016/S0140-6736(06)68507-3. PMID: 16616560.
 24. Luca S, Mihaescu T. History of BCG Vaccine. *Maedica (Bucur)*. 2013 Mar;8(1):53-8. PMID: 24023600; PMCID: PMC3749764.
 25. Tripathi KD. Essentials of medical pharmacology. JP Medical Ltd. September 30, 2013.
 26. Haworth CS, Banks J, Capstick T, Fisher AJ, Gorsuch T, Laurenson IF, Leitch A, Loeblinger MR, Milburn HJ, Nightingale M, Ormerod P, Shingadia D, Smith D, Whitehead N, Wilson R, Floto RA. British Thoracic Society guidelines for the management of non-tuberculous mycobacterial pulmonary disease (NTM-PD). *Thorax*. 2017 Nov;72(Suppl 2):ii1-ii64. doi: 10.1136/thoraxjnl-2017-210927. PMID: 29054853.
 27. Alsultan A, Peloquin CA. Therapeutic drug monitoring in the treatment of tuberculosis: an update. *Drugs*. 2014 Jun;74(8):839-54. doi: 10.1007/s40265-014-0222-8. Erratum in: *Drugs*. 2014 Jun;74(9):2061. Dosage error in article text. PMID: 24846578.
 28. Horsburgh Jr CR, Barry III CE, Lange C. Treatment of tuberculosis. *New England Journal of Medicine*. 2015 Nov 26;373(22):2149-2160. doi: 10.1056/NEJMr1413919.
 29. Ali I, Khan J, Khan AU. Need of advance clinical pharmacy services: A case study from Pakistan. *Archives of Pharmacy Practice*. 2015 Jul 1;6(3). doi: 10.4103/2045 080X.160992.

Shahzad A, Anwar MF, Mian AH, Rehman A, Matiullah. Pharmacotherapy of Different Tuberculosis Patients its Analysis and Outcomes: A Retrospective Cohort Study. *J Biomed Res Environ Sci*. 2021 Nov 29; 2(11): 1154-1158. doi: 10.37871/jbres1363, Article ID: JBRES1363, Available at: <https://www.jelsciences.com/articles/jbres1363.pdf>