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The Safety And Effectiveness Of Shorter Treatment For Rifampicin-Resistant Tuberculosis: Comparative Profile

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Abstract

Literature sources define rifampicin-resistant tuberculosis as a disease caused by a strain of Mycobacterium tuberculosis complex that is resistant to rifampicin. This type of tuberculosis is more difficult to treat than drug susceptible tuberculosis. The conventional longer treatment regimens were not very effective for the treatment of drug-resistant tuberculosis.

A literature review was conducted to describe the evolution of shorter treatment for rifampicin-resistant tuberculosis in the last fourteen-year period. A comparative safety profile of effectiveness and safety of different shorter regimens was provided based on the latest publications and guidelines on tuberculosis. Thirty-seven literature sources were included.

An opportunity to reduce the length of treatment for rifampicin-resistant tuberculosis was presented by the development of novel and repurposed anti-tuberculosis drugs. The implementation of shorter regimens is a promising prospect for tuberculosis care projects. The majority of researchers witness that the application of shorter regimens will improve the effectiveness and safety of anti-tuberculosis treatment, increase the patient's life quality, reduce the program and individual patient costs and increase adherence to treatment. The latest publications presented the effectiveness and good safety profile of BPaL (BPaLM) regimens, 'BEAT-TB trial' regimen, 'endTB trial' schemes, and modified, fully oral nine-month treatment regimens for rifampicin-resistant tuberculosis.

Keywords: shorter treatment, rifampicin-resistant tuberculosis, safety, effectiveness.

1. Introduction

Literature sources define rifampicin-resistant tuberculosis (RR-TB) as a disease caused by a strain of Mycobacterium tuberculosis complex that is resistant to rifampicin. This type of tuberculosis is more difficult to treat than drug susceptible tuberculosis. Thus, there is a critical need for the continual development of evidence-based policy recommendations on the treatment and care of patients with drug-resistance tuberculosis **[1]**. The conventional longer treatment regimens were not very effective for treatment of drug-resistant TB. As noted in the WHO Global TB Report (2020), the «treatment success» rate of these regimens is around 57% **[2]**. Multiple authors consider the side effects and poor tolerability of the drugs to be the main reasons leading to discontinuation of the conventional longer regimens for treatment of RR-TB. Some drugs (aminoglycosides, prothionamide, para-aminosalicylic acid) included in these regimens are prone to cause an extensive list of side effects: gastrointestinal disorders, hepatotoxicity, ototoxicity, acute kidney injury, hypothyroidism, mental and neurological disorders. This brings to low adherence to treatment and interruption of the chemotherapy course **[3-6]**. That is the reason why authors consider it particularly important to apply the principles of pharmacovigilance during the longer and shorter treatment of multidrug-resistant tuberculosis. In particular, it is noted that systematic monitoring of adverse events is the most effective tool for determining the comparative advantage of longer and shorter regimens from a safety perspective. The authors believe that comprehensive knowledge of the drug safety profile allows the creation of more optimal drug combinations and reduction of length of treatment for RR-TB **[7-8]**.

2. Methods

A literature review was conducted to describe the evolution of shorter treatment for rifampicin-resistant tuberculosis in the last fourteen-year period. A comparative safety profile of effectiveness and safety of different shorter regimens was provided based on the latest publications and guidelines on tuberculosis. Thirty-seven literature sources were included.

3. Results

The researchers didn't have a big choice of anti-TB drugs at the initial stages of implementation of shorter regimens. High doses of fluoroquinolones were applied to improve the effectiveness and to shorten the course of anti-TB treatment. The 'treatment success' rates of these regimens were around 80% but the number of cases with QT prolongation increased to 40.5%. **[9]**. Aung K. and coauthors summarized the effectiveness of the high dose gatifloxacin based 'nine-month Bangladesh regimen' among more than 500 patients. The 'treatment success' rate in this population was 84.4% **[10]**. The comparative description of the effectiveness of the 'high dose gatifloxacin based shorter regimen' was presented by the researchers from Niger, depending on the length of chemotherapy **[11]**. The regimen comprised an intensive phase of 4–6 months with kanamycin, medium–high doses of isoniazid, prothionamide, high doses of gatifloxacin, clofazimine, ethambutol, pyrazinamide and a continuation phase of 5-8 months with gatifloxacin, clofazimine, ethambutol, pyrazinamide. Sixty-five patients were treated with this regimen for 12-14 months and 55 patients for 9-11 months. The 'treatment success rates' were 90% / 75% (adults/children and adolescents) with the 12-month regimen and 88% / 83% with the nine-month regimen. Vomiting, ototoxicity and hepatotoxicity were the most frequently reported adverse events. Thus, the risk of ototoxicity related to the injectable agent was the other disadvantage of the 'Bangladesh regimen' after QT prolongation.

Another shorter regimen with injectable agent was studied in Karakalpakstan, Uzbekistan **[12]**. The treatment regimen consisted of seven drugs in the intensive phase: pyrazinamide, ethambutol, high-dose isoniazid, moxifloxacin, capreomycin or kanamycin, prothionamide and clofazimine (Cfz) for 4 to 6 months. This was followed by a fixed five-month continuation phase with pyrazinamide, ethambutol, moxifloxacin, prothionamide and clofazimine. At the end of treatment, 71.9% (92 out of 128) of patients achieved treatment success, with 68% achieving recurrence-free cure at 1 year following completion. Resistance amplification to injectable drugs or fluoroquinolones was confirmed in eight patients. The 'treatment success' rate (71.9%) of this study cohort was lower compared with the patients treated with a gatifloxacin based regimen. The significant number of study participants experienced adverse events related to the injectable agents: impaired hearing (40 cases), acute kidney injury (56 cases), electrolyte loss (9 cases).

Thus, injectable drugs deteriorate the safety profile of shorter regimens. The benefits of shorter injectable-free schemes are fewer adverse events, less travel and reduced time spent in clinics **[1]**. The creation of all-oral shorter regimens with better safety profile and higher effectiveness became possible due to application of new and repurposed anti-TB drugs: bedaquiline, linezolid, delamanid, clofazimine, pretomanid **[13]**.

First of all, the new and repurposed anti-TB drugs contributed to increasing the effectiveness of longer regimens. Thus, according to the data published by S. M. Sauer and coauthors **[14]**, the success rate of longer treatment for multidrug-resistant tuberculosis with regimens including new drugs was 74.3%: 2053 out of 2762 patients. It is important to notify the low rate (7.6/1000) of recurrences registered in this cohort during the six-month post-treatment follow-up period. These authors also emphasized the importance of evaluation of shorter regimens from the perspective of tuberculosis recurrence (2024). Summarizing what has been stated, the use of longer regimens with new and repurposed drugs was a bridge on the way to transition from the conventional injectable based treatment to shorter all-oral regimens.

In general, the emergence of new, more effective anti-tuberculosis drugs is the main promise for shortening the duration of treatment for rifampicin-resistant tuberculosis. Of these drugs, bedaquiline has gained particular importance, and its role in establishing the effectiveness of short-term regimens has been evaluated in various combinations of anti-tuberculosis drugs. The aforementioned studies **[15-16]** suggested that bedaquiline may shorten the duration of MDR-TB treatment while maintaining a 'success rate' of 95-100%, and the average period needed for sputum transformation was 27-44 days **[17]**. The potential of bedaquiline to shorten the duration of treatment has also been studied in an experimental animal model, resulting in faster sterilization in mice **[18]**. However, it should be noted that there was a bedaquiline-free, nine-month shorter regimen studied in South Korea **[19]**. This regimen was composed of levofloxacin, linezolid, delamanid and pyrazinamide. The 'treatment success' rate (75%) of the bedaquiline-free shorter regimen was 4.4% higher compared with the longer regimens administered to the patients in the control group. One of the oral shorter regimens recommended by the WHO consisted of the following drugs: bedaquiline, levofloxacin, ethionamide (prothionamide), ethambutol, high dose isoniazid (900 mg), pyrazinamide and clofazimine. The effectiveness of this drug combination was witnessed by the WHO Global Reports **[2, 20]**. However, the new classification of drugs for the treatment of drug-resistant tuberculosis made it necessary to include in the all-oral shorter regimens at least three Group 'A' medicines: bedaquiline, levofloxacin, linezolid **[1]**. This was a new qualitative requirement for shorter RR-TB treatment regimens. A. Esmail and coauthors **[21]** compared the effectiveness of conventional injectable-containing regimens with a six-month shorter regimen composed of three Group 'A' drugs (bedaquiline, levofloxacin, linezolid). In total, 93 patients participated in this randomized trial. HIV positive participants made up more than half of the study cohort (55%). The authors revealed significantly improved treatment outcomes associated with the six-month all-oral shorter regimen. The participants exposed to the shorter regimen were 2.2 times more likely to experience favorable outcomes compared with the conventional injectable-based treatment.

In terms of side effects, the most unfavorable drugs among the components of both regimens were kanamycin (hearing loss) and linezolid (anemia).

Researchers from South Africa conducted a retrospective cohort analysis on RR-TB patients treated with the standardized all-oral shorter regimen including bedaquiline and linezolid as core drugs **[22]**. This study shows the outcomes of the shorter regimen in a high HIV burden rural setting. Of 117 patients included in the study cohort, 80 (68.4%) were tested positive for human immunodeficiency virus. Treatment success was achieved in 75.2% of patients. Anemia was the most frequent adverse event (25.2%) resulting in discontinuation of linezolid for 27 patients. Ten patients who died of anemia composed 66.7% of the cases with a 'death' outcome. Hepatotoxicity and prolonged QT interval were observed in 14.5% and 11.3% of the cohort. Only one patient experienced peripheral neuropathy. The authors explain the low frequency of peripheral neuropathy by the short linezolid exposure limited to two months and possibly underdiagnosis of the pathology. Unfortunately, one patient developed optic neuritis and lost all vision. Despite the high 'treatment success' rate, significant proportions of 'death' (12.8%) and 'failed treatment' (10.3%) outcomes were registered. Two patients had culture results with amplified resistance profiles.

The latest publication describes the effectiveness and safety of modified fully oral nine-month treatment regimens (mSTR) for rifampicin-resistant tuberculosis **[23]**. The treatment cohort included 2636 participants. The patients of the study population received one of the three shorter regimens: bedaquiline - linezolid - levofloxacin - clofazimine - cycloserine; bedaquiline - linezolid - levofloxacin - clofazimine - delamanid (in case of suspected resistance or intolerance to Cs); delamanid - linezolid - levofloxacin - clofazimine (for children aged below six years). These regimens were composed on the background of the shorter regimen (bedaquiline, levofloxacin, ethionamide, ethambutol, high-dose isoniazid, pyrazinamide, and clofazimine) prioritized in WHO guidelines **[24]** by replacing ethionamide, ethambutol, isoniazid, and pyrazinamide with new and repurposed drugs, including linezolid, cycloserine, or delamanid. The authors indicate notable potential for the use of mSTRs in programmatic condition considering the high treatment success (82.7%) and good safety results. The most frequent adverse event was myelosuppression (4.9%) followed by QT interval prolongation (1.7%), peripheral neuropathy (1.1%), hepatitis (0.9%), optic neuritis (0.6%), acute kidney injury (0.5%) and hypokalaemia (0.2%). Another publication presented the safety of the mSTRs applied in Armenia **[25]**. The treatment success rate of the mSTR study cohort was 75%. The pattern of adverse events registered during the application of the mSTRs in Armenia was different compared with the results presented by the WHO experts. Arthralgia (23.1%) and peripheral neuropathy (21.2%) took leading positions among the adverse events resulting in modifications of the mSTRs in Armenia. The authors come to a conclusion that the mSTRs proved to be safe and effective, but proper follow-up of adverse events is necessary.

The most popular shorter regimens for the treatment of rifampicin-resistant tuberculosis are the BPaL and BPaLM regimens. WHO suggests the use of these shorter regimens rather than 9-month or longer (18-month) regimens in multidrug-resistant tuberculosis (MDR/RR-TB) patients **[1]**. The BPaL regimen is composed of bedaquiline, pretomanid and linezolid (600 mg). This regimen is used in patients with MDR-TB that is resistant to fluoroquinolones. The BPaLM regimen is used in MDR-TB patients if the sensitivity to fluoroquinolones is preserved. This regimen includes four drugs bedaquiline, pretomanid, linezolid and moxifloxacin. The standard treatment duration for both regimens is six months. Extension to 9 months applies if sputum culture is positive at 4-6 months of the BPaL regimen. Discontinuation of bedaquiline and pretomanid brings to a 'failed treatment' outcome. Linezolid can be discontinued after the initial 9 weeks of treatment. In cases of documented resistance to fluoroquinolones or intolerance, moxifloxacin can be dropped from the BPaLM regimen and BPaL without moxifloxacin would be continued. A disadvantage of the BPaL and BPaLM regimens is the contraindication for the use of these treatment schemes among pregnant or breastfeeding patients and the children under 14 years of age. It should be noted that BPaL with linezolid 600 mg/daily was considered preferable (compared with BPaL with linezolid 1200 mg/daily), but the dose can be reduced to 300 mg/daily if necessary to mitigate toxicity.

O. Korotych and coauthors **[23]** compared the real-world performance of BPaLM treatment (82%) with the success rates of the mSTRs (82.7%). The authors considered mSTRs complementary to BPaLM since the medicines included in the mSTRs are recommended for use without age restrictions and during pregnancy or breastfeeding. The safety findings of the mSTR study were close to the data of TB-PRACTECAL and ZeNix trials that studied the shorter regimens with pretomanid, severe myelosuppression occurred among 3% (TB-PRACTECAL trial) and 4,4% (ZeNix trial), severe QT prolongation affected 1% of participants in the TB-PRACTECAL trial and 2% in the ZeNix trial. The presence of bilateral cavities in the lungs decreased the chance of successful shorter treatment. Although the clinical trial of BPaLM did not show variation in treatment success related to the presence of cavities, real-world BPaLM outcomes indicate diminished sputum culture conversion in such patients **[26]**. The researchers explain this observation by decreasing drug penetration into cavity lesions **[27]**. Therefore, the early case identification followed by rapid initiation of effective treatment is considered as a best way to prevent the development of extensive disease **[23]**.

Three new shorter, nine-month regimens are recommended by the WHO consolidated guideline on tuberculosis (2025): bedaquiline - linezolid - moxifloxacin – pyrazinamide, bedaquiline - linezolid -

levofloxacin - clofazimine - pyrazinamide and bedaquiline - delamanid - linezolid - levofloxacin - pyrazinamide. A high 'treatment success' rate (80.7%) is reported for the standard therapy group exposed to these regimens in the framework of 'endTB trial' **[28]**. Hepatotoxicity (grade 3) presumably related to pyrazinamide was registered among the study population receiving the abovementioned shorter schemes (8.7-18%). The same guideline (WHO, 2025) recommends applying the following regimen for six months (BEAT-TB trial regimen): bedaquiline - linezolid - levofloxacin - clofazimine - delamanid **[29]**. The composition of this regimen matches that of the mSTR scheme II, but it can be prescribed without levofloxacin. The regimen is the best option for treating rifampicin- and fluoroquinolone-resistant tuberculosis over a six-month period in children under 14 years of age and pregnant women.

M. Lee and co-authors **[30]** have identified three anticipated advantages of using short-term regimens to treat multidrug-resistant tuberculosis: decreased cost, improved adherence to therapy, and a decreased incidence of side effects. Many authors share abovementioned opinion **[31-35]**. According to I. Walker **[36]**, patients undergoing treatment for multidrug-resistant tuberculosis experience fewer treatment interruptions while following short-term regimens (2019). The use of short-course regimens in tuberculosis control efforts is therefore highly alluring, and it is no accident that, based on the information provided in the 2022 Global Tuberculosis Report **[37]**, the number of nations treating rifampicin-resistant TB with short-course regimens of different compositions has grown dramatically, rising from 65 in 2020 to 92 in 2022.

4. Discussion

Summarizing the results of this review, the following highlights regarding the implementation of short-term regimens are formulated.

- The emergence of new and repurposed anti-TB drugs created an opportunity to shorten the length of treatment for rifampicin-resistant tuberculosis.
- The exclusion of injectable drugs from shorter regimens will contribute to the safety of anti-TB therapy, making treatment safer and more patient centered.
- However, adverse events occurring during the use of various short-term regimens indicate the need for active pharmacovigilance when treating patients with these schemes.
- Given the higher risk of adverse events associated with high doses of anti-TB drugs, such as with high-dose fluoroquinolones or linezolid, it is more rational to compose effective drug combinations rather than apply high-dose anti-tuberculosis drugs when building shorter regimens for treatment of rifampicin-resistant tuberculosis.
- In addition to increasing treatment effectiveness and safety, the adoption of short-term regimens is beneficial for the rational organization of tuberculosis care programs, which is due to the reduction of program and individual patient costs and increased adherence to treatment.

Conclusions

The implementation of shorter regimens is a promising prospective for TB care projects. The majority of researchers witness that the application of shorter regimens will improve the effectiveness and safety of anti-tuberculosis treatment and increase the patient's life quality. The latest publications presented the effectiveness and good safety profile of BPaL (BPaLM) regimens, 'BEAT-TB trial' regimen, 'endTB trial' schemes, and modified, fully oral nine-month treatment regimens (mSTR) for rifampicin-resistant tuberculosis.

References

1. WHO consolidated guidelines on tuberculosis. Module 4: treatment - drug-resistant tuberculosis treatment. (2022). update.
2. Byrne F (2020) Global Tuberculosis Report 2020.
3. Yang TW, Park HO, Jang HN, Yang JH, Kim SH, et al. (2017) Side effects associated with the treatment of multidrug-resistant tuberculosis at a tuberculosis referral hospital in South Korea. Medicine (Baltimore). 96(28): e7482.
4. Nguyen TMP, Le THM, Merle CSC, Pedrazzoli D, Nguyen NL, et al. (2023) Effectiveness and safety of bedaquiline-based, modified all-oral 9–11-month treatment regimen for rifampicin-resistant tuberculosis in Vietnam. Int J Infect Dis. 126: 148-154.
5. Jang JG, Chung JH (2020) Diagnosis and treatment of multidrug-resistant tuberculosis. Yeungnam Univ J Med. 37(4): 277-285.
6. Karnan A, Jadhav U, Ghewade B, Ledwani A, Shivashankar P (2024) A Comprehensive review on long vs. short regimens in multidrug-resistant tuberculosis under programmatic management of drug-resistant tuberculosis. Cureus. 16(1): e52706.
7. Nyang'wa BT, Berry C, Kazounis E, Motta I, Parpieva N, et al. (2024) Short oral regimens for pulmonary rifampicin-resistant tuberculosis (TB-PRACTECAL): an open-label, randomised, controlled, phase 2B-3, multi-arm, multicentre, non-inferiority trial. Lancet Respir Med. 12(2): 117-128.
8. Trubnikov A, Hovhannesyan A, Akopyan K, Ciobanu A, Sadirova D, et al. (2021) Effectiveness and safety of a shorter treatment regimen in a setting with a high burden of multidrug-resistant tuberculosis. Int J Environ Res Public Health. 18(8): 4121.
9. Nie Q, Tao L, Li Y, Chen N, Chen H, et al. (2022) High-dose gatifloxacin-based shorter treatment regimens for MDR/RR-TB. Int J Infect Dis. 2022; 115: 142-148.

10. Aung KJ, Van Deun A, Declercq E, Sarker MR, Das PK, et al. (2014) Successful "9-month Bangladesh regimen" for multidrugresistant tuberculosis among over 500 consecutive patients. Int J Tuberc Lung Dis. 18(10): 1180-7.
11. Harouna SH, Ortuno-Gutierrez N, Souleymane MB, Kizito W, Morou S, et al. (2019) Short-course treatment outcomes and adverse events in adults and children-adolescents with MDR-TB in Niger. Int. J. Tuberc. Lung Dis. 23(5): 625-630.
12. Du Cros P, Khamraev A, Tigay Z, Abdrasuliev T, Greig J, et al. (2021) Outcomes with a shorter multidrug-resistant tuberculosis regimen from Karakalpakstan, Uzbekistan. ERJ Open Res. 7(1): 00537-2020.
13. Espinosa-Pereiro J, Sánchez-Montalvá A, Aznar ML, Espiau M (2022) MDR Tuberculosis Treatment. Medicina (Kaunas). 58(2): 188.
14. Sauer SM, Mitnick CD, Khan U, Hewison C, Bastard M, et al. (2024) Estimating post-treatment recurrence after multidrug-resistant tuberculosis treatment among patients with and without Human Immunodeficiency Virus: The Impact of assumptions about death and missing follow-up. Clin Infect Dis. 78(1): 164–171.
15. Doan TN, Cao P, Emeto TI, McCaw JM, McBryde ES (2018) Predicting the outcomes of new short-course regimens for multidrug-resistant tuberculosis using intra-host and pharmacokinetic-pharmacodynamic modeling. Antimicrob Agents Chemother. 62(12): e01487-18.
16. Kendall EA, Fojo AT, Dowdy DW (2017) Expected effects of adopting a 9 month regimen for multidrug-resistant tuberculosis: a population modelling analysis. Lancet Respir Med. 5(3): 191-199.
17. Русских АЕ, Кутузова ДМ, Ловачева ОВ, Самойлова А, Васильева ИА (2020) Краткосрочные схемы лечения больных туберкулезом с множественной лекарственной устойчивостью. Современная ситуация и дальнейшие перспективы. Туберкулез и болезни легких. 98(12): 57-66.
18. Veziris N, Ibrahim M, Lounis N, Andries K, Jarlier V (2011) Sterilizing activity of second-line regimens containing TMC-207 in a murine model of tuberculosis. PLoS One. 6(3): e17556.
19. Mok J, Lee M, Kim DK, Kim JS, Jhun BW, et al. (2022) 9 months of delamanid, linezolid, levofloxacin, and pyrazinamide versus conventional therapy for treatment of fluoroquinolone-sensitive multidrug-resistant tuberculosis (MDR-END): a multicentre, randomised, open-label phase 2/3 non-inferiority trial in South Korea. Lancet. 400(10362): 1522-1530.
20. Chakaya J, Khan M, Ntoumi F, Aklillu E, Fatima R, et al. (2021) Global Tuberculosis Report 2020 – Reflections on the Global TB burden, treatment and prevention efforts. Int J Infect Dis. 13 Suppl 1(Suppl 1): S7-S12
21. Esmail A, Oelofse S, Lombard C, Perumal R, Mbuthini L, et al. (2022) An all-oral 6-month regimen for multidrug-resistant tuberculosis: a multicenter, randomized controlled clinical trial (the NExT Study). Am J Respir Crit Care Med. 205(10): 1214-1227.
22. Tack I, Dumicho A, Ohler L, Shigayeva A, Bulti AB, et al. (2021) Safety and effectiveness of an all-oral, bedaquiline-based, shorter treatment regimen for rifampicin-resistant tuberculosis in high Human Immunodeficiency Virus (HIV) burden rural South Africa: A retrospective cohort analysis. Clin Infect Dis. 73(9): e3563-e3571.
23. Korotych O, Achar J, Gurbanova E, Hovhannesyan A, Lomtadze N, et al. (2024) Effectiveness and safety of modified fully oral 9-month treatment regimens for rifampicin-resistant tuberculosis: a prospective cohort study. Lancet Infect Dis. 24(10): 1151-1161
24. WHO Consolidated guidelines on tuberculosis, Module 4: treatment – drug-resistant tuberculosis treatment (electronic resource). (2020).
25. Atshemyan H, Khachatryan N, Khachatryan A, Mirzoyan N (2024) The safety of modified, all-oral shorter tuberculosis regimens in Armenia. Int J Risk Saf Med. 35(3): 287-295.
26. Sangsayunh P, Sanchat T, Chuchottaworn C, Cheewakul K, Rattanawai S (2023) The use of BPaL-containing regimen in the MDR/ preXDR TB treatments in Thailand. J Clin Tuberc Other Mycobact Dis. 34: 100408.
27. Kempker RR, Barth AB, Vashakidze S, Nikolaishvili K, Sabulua I, et al. (2015) Cavitary penetration of levofloxacin among patients with multidrug-resistant tuberculosis. Antimicrob Agents Chemother. 59(6): 3149-55.
28. Guglielmetti L, Khan U, Velásquez GE, Gouillou M, Abubakirov A, et al. (2025) Oral regimens for rifampin-resistant, fluoroquinolone-susceptible tuberculosis. N Engl J Med. 392(5): 468-482.
29. WHO Consolidated guidelines on tuberculosis, Module 4: Treatment and care. (2025).
30. Lee M, Mok J, Kim DK, Shim TS, Koh WJ, et al. (2019) Delamanid, linezolid, levofloxacin, and pyrazinamide for the treatment of patients with fluoroquinolone-sensitive multidrug-resistant tuberculosis (Treatment Shortening of MDR-TB Using Existing and New Drugs, MDR-END): study protocol for a phase II/III, multicenter, randomized, open-label clinical trial. BMC. 20(1): 57.
31. Churchyard GJ (2019) A Short Regimen for Rifampin-Resistant Tuberculosis. N Engl J Med. 380(13): 1279-1280.
32. Leung CC, Leung EC, Yew WW (2010) Can some patients with multidrug-resistant tuberculosis be cured with shorter duration of chemotherapy?. Am J Respir Crit Care Med. 182(12): 1570.

33. Silva DR, Mello FCQ, Migliori GB (2020) Shortened tuberculosis treatment regimens: what is new?. J Bras Pneumol. 46(2): e20200009.
34. Mpobela Agnarson A, Williams A, Kambili C, Mattson G, Metz L (2020) The cost-effectiveness of a bedaquiline-containing short-course regimen for the treatment of multidrug-resistant tuberculosis in South Africa. Expert Rev Anti Infect Ther. 18(5): 475-483.
35. Sotgiu G, Tiberi S, Centis R, D'Ambrosio L, Fuentes Z, et al. (2017) Applicability of the shorter 'Bangladesh regimen' in high multidrug-resistant tuberculosis settings. Int J Infect Dis. 56: 190–3.
36. Walker IF, Shi O, Hicks JP, Elsey H, Wei X, et al. (2019) Menzies D et al. Analysis of loss to follow-up in 4099 multidrug-resistant pulmonary tuberculosis patients. Eur Respir J. 54(1): 1800353.
37. WHO Global tuberculosis report 2022.