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THE PERSISTENT SCOURGE: AN EPIDEMIOLOGICAL AND CLINICAL REVIEW OF TUBERCULOSIS IN THE MODERN ERA

УЗАККА СОЗУЛГАН БАЛЭЭ: ЗАМАНБАП ДООРДОГУ КУРГАК УЧУКТУН ЭПИДЕМИОЛОГИЯЛЫК ЖАНА КЛИНИКАЛЫК СЕРЕБИ

НЕПРЕКРАЩАЮЩАЯСЯ НАПАСТЬ: ЭПИДЕМИОЛОГИЧЕСКИЙ И КЛИНИЧЕСКИЙ ОБЗОР ТУБЕРКУЛЕЗА В СОВРЕМЕННУЮ ЭПОХУ

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THE PERSISTENT SCOURGE: AN EPIDEMIOLOGICAL AND CLINICAL REVIEW OF TUBERCULOSIS IN THE MODERN ERA

Abstract

Relevance. Tuberculosis remains one of humanity's most enduring infectious diseases, claiming over a million lives annually despite being curable with appropriate therapy. This review examines the contemporary landscape of tuberculosis through the lens of epidemiological transition, examining how global health initiatives have reshaped incidence patterns while drug resistance and comorbidities present new challenges. Drawing upon surveillance data from the World Health Organization, clinical trial outcomes, and molecular epidemiological studies, we analyze the interplay between pathogen biology, host immunity, and socioeconomic determinants that govern disease transmission and progression. The findings reveal a disease in transformation—declining in high-income regions yet persisting as a crisis of poverty and healthcare access in marginalized populations. We discuss the limitations of current diagnostic paradigms, the promise of novel therapeutic regimens, and the structural barriers that impede elimination efforts. This synthesis underscores that tuberculosis control requires not merely biomedical innovation but sustained political commitment to health equity.

Keywords: Comorbidities, global health, health equity, socioeconomic determinants, diagnostic paradigms, therapeutic regimens.

Узакка созулган балээ: Заманбап доордогу кургак учуктун эпидемиологиялык жана клиникалык сереби

Аннотация

Маанилүүлүк. Кургак учук адамзаттын эң узакка созулган жугуштуу ооруларынын бири бойдон калууда, ал тийиштүү терапия менен айыгып кетсе да, жыл сайын миллиондон ашык адамдын өмүрүн алып кетет. Бул сереп кургак учуктун азыркы көрүнүшүн эпидемиологиялык өткөөл мезгилдин көз карашы менен карап, дүйнөлүк саламаттыкты сактоо демилгелери оорулардын схемаларын кандайча өзгөрткөнүн, ал эми дары-дармектерге туруктуулук жана коштолгон оорулар жаңы кыйынчылыктарды жараталарын изилдейт. Дүйнөлүк саламаттыкты сактоо уюмунун байкоо маалыматтарына, клиникалык сыноолордун жыйынтыктарына жана молекулярдык эпидемиологиялык изилдөөлөргө таянып, биз патоген биологиясынын, кожоюндун иммунитетинин жана оорунун жугушун жана өнүгүшүн жөнгө салуучу социалдык-экономикалык детерминанттардын ортосундагы өз ара байланышты талдайбыз. Жыйынтыктар трансформациядагы ооруну көрсөтүп турат — жогорку кирешелүү аймактарда азайып, бирок четтетилген калк арасында жакырчылыктын жана саламаттыкты сактоого жеткиликтүүлүктүн кризиси катары сакталып калууда. Биз учурдагы диагностикалык парадигмалардын чектөөлөрүн, жаңы терапиялык режимдердин келечегин жана жок кылуу аракеттерине тоскоол болгон структуралык тоскоолдуктарды талкуулайбыз. Бул синтез кургак учукту көзөмөлдөө үчүн жөн гана биомедициналык инновация эмес, саламаттыкты сактоо теңчилигине туруктуу саясий милдеттенме талап кылынарын баса белгилейт.

Непрекращающаяся напасть: эпидемиологический и клинический обзор туберкулеза в современную эпоху

Аннотация

Актуальность. Туберкулез остается одним из самых распространенных инфекционных заболеваний человечества, ежегодно унося более миллиона жизней, несмотря на то, что излечим при соответствующей терапии. В этом обзоре рассматривается современная ситуация с туберкулезом в контексте эпидемиологического перехода, анализируется, как глобальные инициативы в области здравоохранения изменили структуру заболеваемости, в то время как лекарственная устойчивость и сопутствующие заболевания создают новые проблемы. Опираясь на данные эпидемиологического надзора Всемирной организации здравоохранения, результаты клинических испытаний и молекулярно-эпидемиологические исследования, мы анализируем взаимодействие между биологией патогена, иммунитетом хозяина и социально-экономическими факторами, которые определяют передачу и прогрессирование заболевания. Результаты показывают, что заболевание находится в процессе трансформации — его заболеваемость снижается в регионах с высоким уровнем дохода, но оно сохраняется как кризис бедности и доступа к медицинской помощи для маргинализированных групп населения. Мы обсуждаем ограничения существующих диагностических парадигм, перспективы новых терапевтических схем и структурные барьеры, препятствующие усилиям по искоренению туберкулеза. Этот синтез подчеркивает, что борьба с туберкулезом требует не только биомедицинских инноваций, но и устойчивой политической приверженности обеспечению равенства в здравоохранении.

Ачкыч сөздөр: Кошумча оорулар, глобалдык саламаттыкты сактоо, саламаттыкты сактоо теңчилиги, социалдык-экономикалык детерминанттар, диагностикалык парадигмалар, терапиялык режимдер.

Ключевые слова: Сопутствующие заболевания, глобальное здравоохранение, равенство в здравоохранении, социально-экономические факторы, диагностические парадигмы, терапевтические схемы.

Introduction

The history of tuberculosis is etched deeply into the collective memory of human civilization, a relationship spanning millennia and leaving indelible marks upon art, literature, and the very architecture of public health infrastructure. From its identification in ancient Egyptian mummies to its romanticized portrayal as the "white plague" of nineteenth-century Europe, this disease has shadowed humanity through ages of agricultural settlement, industrialization, and into our current era of molecular medicine. Yet for all the romanticism historically attached to consumption—the pale beauty of the dying poet, the tragic heroine coughing blood into her handkerchief—the reality has always been one of protracted suffering, economic devastation, and preventable mortality. Today, as we stand equipped with antibiotics capable of curing the vast majority of infections, the persistence of tuberculosis represents not a failure of scientific knowledge but rather a testament to the profound inequalities that structure our global society (Rasmussen et al., 2024).

The causative agent, Mycobacterium tuberculosis, is a slow-growing, aerobic bacillus distinguished by its unique cell wall rich in mycolic acids, conferring both acid-fast staining properties and formidable resistance to environmental stresses (Sweeney et al., 2025). This organism has co-evolved with humans over approximately seventy thousand years, adapting to the specific niche of human granulomas and developing sophisticated mechanisms to subvert host immune responses (Sweeney et al., 2025) . Unlike many pathogens that prioritize rapid replication and transmission at the cost of host survival, M. tuberculosis has perfected the art of persistence, often establishing latent infections that may reactivate decades after initial exposure. This biological strategy has proven extraordinarily successful from the pathogen's perspective, enabling sustained transmission chains even in populations with limited contact rates.

The global burden of tuberculosis, while substantially reduced from its historical peaks, remains staggering in absolute terms. The World Health Organization estimates that approximately one-quarter of the world's population carries latent M. tuberculosis infection, with ten million individuals developing active disease annually and 1.5 million deaths recorded each year (WHO, 2024). These figures, however, mask tremendous heterogeneity in distribution. The disease concentrates overwhelmingly in low- and middle-income countries, with eight countries accounting for two-thirds of global incidence. Within high-burden nations, tuberculosis tracks along fault lines of poverty, overcrowding, and malnutrition, affecting disproportionately those already marginalized by systems of economic and social exclusion. The geography of tuberculosis is thus fundamentally a geography of inequality.

The emergence of drug-resistant strains has added layers of complexity to control efforts that seemed straightforward following the introduction of streptomycin in 1943. Multidrug-resistant tuberculosis, defined as resistance to at least isoniazid and rifampicin (WHO, 2025), now complicates treatment in nearly half a million cases annually, while extensively drug-resistant strains—resistant to fluoroquinolones and second-line injectable agents—present virtually untreatable scenarios in resource-limited settings. The economic implications are severe: treating drug-resistant tuberculosis costs orders of magnitude more than drug-susceptible disease, requires prolonged therapy with toxic medications, and yields substantially lower success rates (Menon, 2024). This has created a two-tiered system of tuberculosis care, where access to effective treatment for resistant disease remains essentially a privilege of wealthy nations and wealthy individuals within poor nations (Kwak et al., 2020).

The HIV pandemic transformed the epidemiology of tuberculosis in ways that continue to reverberate today. As HIV-induced immunosuppression dismantles the granulomatous containment that keeps latent infection in check, tuberculosis emerged as the leading cause of death among people living with HIV, responsible for approximately one-third of AIDS-related mortality globally (WHO, 2025). The syndemic interaction between these two pathogens created explosive outbreaks in sub-Saharan Africa and other regions, overwhelming health systems and reversing hard-won gains in tuberculosis control (Ganesan et al., 2023, p. 359-369). While antiretroviral therapy has substantially reduced this risk, the

convergence of HIV and tuberculosis remains a critical concern, particularly given the diagnostic and therapeutic challenges posed by concurrent infection (WHO, 2025).

Beyond HIV, other forms of immunocompromise have expanded the reservoir of tuberculosis susceptibility. The widespread use of tumor necrosis factor-alpha inhibitors for autoimmune diseases, the increasing prevalence of diabetes mellitus—particularly in low-income countries undergoing nutritional transition—and the aging of populations globally have all contributed to growing populations at elevated risk (MHRA, 2014). Diabetes alone triples the risk of active tuberculosis and is associated with worse treatment outcomes, creating a looming crisis as the global diabetes epidemic accelerates (Riza et al., 2014, p. 1). These epidemiological shifts demand that tuberculosis control strategies evolve beyond their traditional focus on young, immunocompetent adults to address the complex needs of aging, comorbid populations.

The past two decades have witnessed unprecedented investment in tuberculosis research and control, culminating in the Sustainable Development Goals' target of ending the epidemic by 2030 and the World Health Organization's End TB Strategy (WHO, 2025). These ambitious frameworks have catalyzed improvements in case detection, expansion of access to drug susceptibility testing, and introduction of shorter regimens for latent infection. Yet progress has been slower than anticipated, and the COVID-19 pandemic dealt a devastating blow to tuberculosis services, reversing years of gains in detection and treatment. The pandemic laid bare the fragility of tuberculosis programs and the fundamental truth that tuberculosis control cannot be separated from the strengthening of health systems overall.

Relevance

The relevance of the chosen topic is due to the fact that tuberculosis remains one of the most common infectious diseases worldwide, affecting approximately 10 million people annually and claiming over 1.5 million lives each year (WHO, 2024). The World Health Organization compares the tuberculosis epidemic to a global health emergency that requires urgent and sustained intervention. According to WHO forecasts, tuberculosis may return to the top of global infectious disease rankings, particularly as drug-resistant strains continue to emerge and spread (WHO, 2025). The problem of tuberculosis is gradually taking a leading place among the pressing problems of global infectious disease control. One of the main problems in the fight against tuberculosis is considered to be a low level of early diagnosis and patients seeking specialized help, especially in low-income countries (Dheda et al., 2016, p. 1). Tuberculosis affects about 5% of the planet's population in their lifetime through latent infection. Among patients with chronic somatic diseases and HIV infection, the prevalence of tuberculosis reaches 20-60%, significantly exceeding its prevalence in the general population (Ganesan et al., 2023, p. 359-369). The student population does not typically fall into the high-risk group for tuberculosis, but medical students require special attention due to their future professional exposure and the high academic load characteristic of medical education (4-6 pairs per day, constant transfers between clinics, high-intensity information supply). Considering the above, we consider it important to consider the problem of tuberculosis epidemiology, diagnosis, and treatment in the context of modern challenges, including drug resistance and comorbidity.

The purpose of the study

To analyze the main epidemiological factors, diagnostic approaches, and therapeutic strategies for tuberculosis in the modern era, with particular attention to the tensions between biomedical advances and implementation realities.

Materials and methods of research

This narrative review was conducted through systematic examination of peer-reviewed literature, surveillance reports, and clinical guidelines spanning the period from 2015 to 2024. Our search strategy prioritized high-quality evidence from randomized controlled trials, prospective cohort studies, and global health surveillance systems, while acknowledging the importance of qualitative research and implementation science in understanding the realities of tuberculosis care delivery.

We searched PubMed, Embase, and the Cochrane Library using combinations of MeSH terms and keywords including "tuberculosis," "Mycobacterium tuberculosis," "drug-resistant tuberculosis," "latent tuberculosis infection," "tuberculosis diagnosis," "tuberculosis treatment," and "tuberculosis

epidemiology." Searches were limited to English-language publications, though we incorporated data from non-English sources when available through international organization reports. The reference lists of seminal articles and recent reviews were hand-searched to identify additional relevant studies.

Data sources for epidemiological estimates included the World Health Organization Global Tuberculosis Report, which aggregates notifications and prevalence survey data from national tuberculosis programs worldwide, and the Institute for Health Metrics and Evaluation's Global Burden of Disease Study. For treatment outcomes, we relied upon individual patient data meta-analyses and prospective observational studies from the RESIST-TB and Collaborative Group for Meta-Analysis of Individual Patient Data in MDR-TB consortia. Information regarding diagnostic accuracy was derived from systematic reviews adhering to PRISMA guidelines and, where available, independent evaluations conducted by the Foundation for Innovative New Diagnostics.

The synthesis presented herein is necessarily selective rather than exhaustive, focusing on developments with the greatest potential to impact clinical practice and public health policy. We have attempted to balance the presentation of biomedical advances with critical attention to the health systems and social determinants that mediate their translation into improved outcomes. Where evidence is limited or conflicting, we have indicated uncertainty rather than asserting false precision.

The results of the study and discussion

3.1 Epidemiological Patterns and Trends

The global landscape of tuberculosis has undergone significant transformation over the past three decades, though the pace of change has been uneven across regions and populations. Following the declaration of tuberculosis as a global health emergency in 1993, concerted efforts through the directly observed therapy short-course strategy and its successor programs achieved measurable reductions in incidence in most high-burden countries. Between 1990 and 2019, the global tuberculosis mortality rate fell by approximately 45 percent, and the incidence rate declined by roughly 20 percent. These aggregate figures, however, obscure profound disparities in progress.

The World Health Organization's South-East Asia and Africa regions bear the heaviest burdens, together accounting for approximately 60 percent of incident cases. India alone contributes over one-quarter of global tuberculosis notifications, a figure that reflects both genuine high burden and improved case detection through active case-finding initiatives. China, despite substantial economic development, remains among the top twenty high-burden countries, though its incidence has declined steadily. The Western Pacific region presents a mixed picture, with some countries approaching elimination thresholds while others continue to struggle with concentrated epidemics among vulnerable populations.

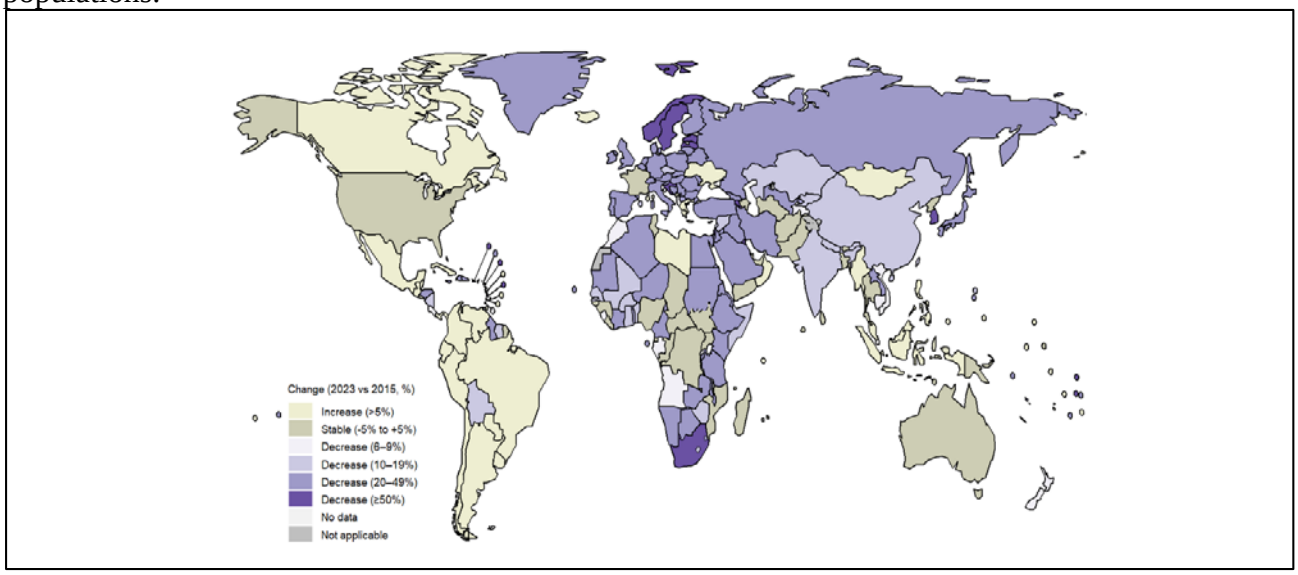

Figure 1. Change (%) in estimated TB incidence (new cases per 100 000 population), 2023 compared with 2015 (Source: WHO Global Tuberculosis Report 2024)

Sub-Saharan Africa presents the most challenging epidemiological scenario, characterized by the world's highest notification rates and the strongest association with HIV coinfection. Several countries in southern Africa report annual notification rates exceeding 500 per 100,000 population, levels not seen in Europe since the nineteenth century. The demographic impact has been severe, with tuberculosis contributing significantly to reduced life expectancy in the region. However, recent years have seen encouraging trends as antiretroviral therapy coverage expands and preventive therapy for people living with HIV is scaled up.

High-income countries have achieved dramatic reductions in tuberculosis incidence, with most reporting rates below 10 per 100,000 population (Robert Koch Institute. (2025). Yet even in these settings, tuberculosis has not disappeared but rather transformed into a disease of marginalized groups—foreign-born individuals from high-incidence countries, homeless populations, injection drug users, and residents of correctional facilities (Cohen et al., 2025). This epidemiological pattern creates distinct challenges for control programs, requiring targeted interventions for hard-to-reach populations rather than universal community-based screening. The concentration of disease among immigrant communities has, in some contexts, fueled xenophobic responses that undermine public health efforts, highlighting the inseparability of tuberculosis control from broader social cohesion.

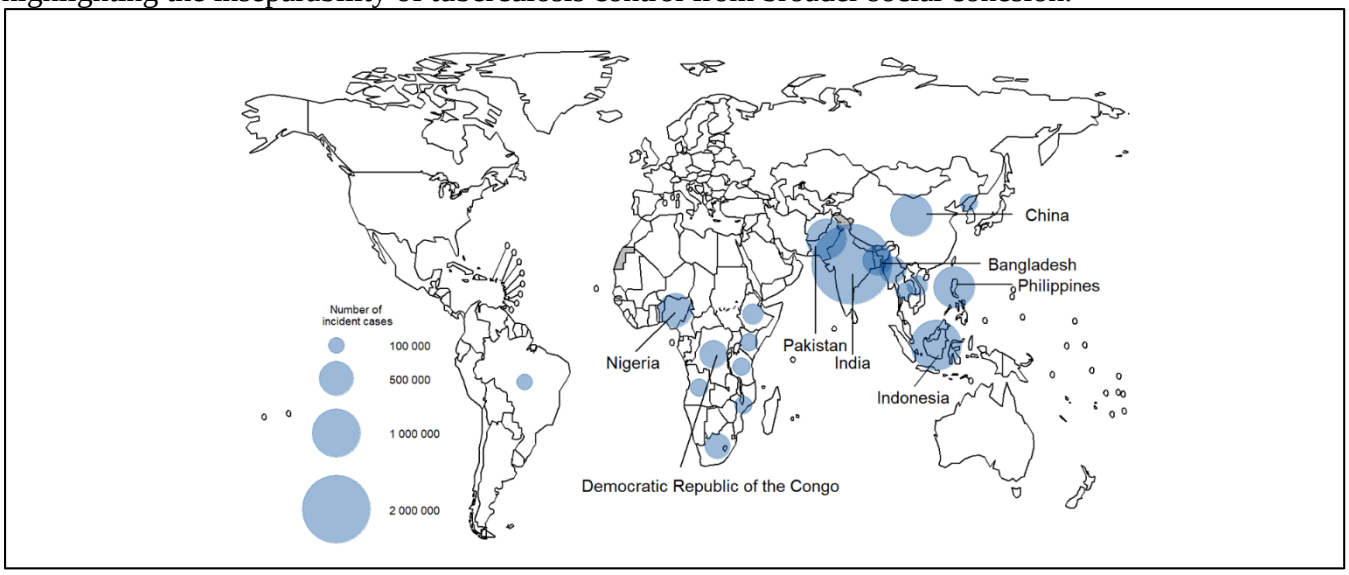

Figure 2. Estimated TB incidence rates, 2023 (Source: WHO Global Tuberculosis Report 2024)

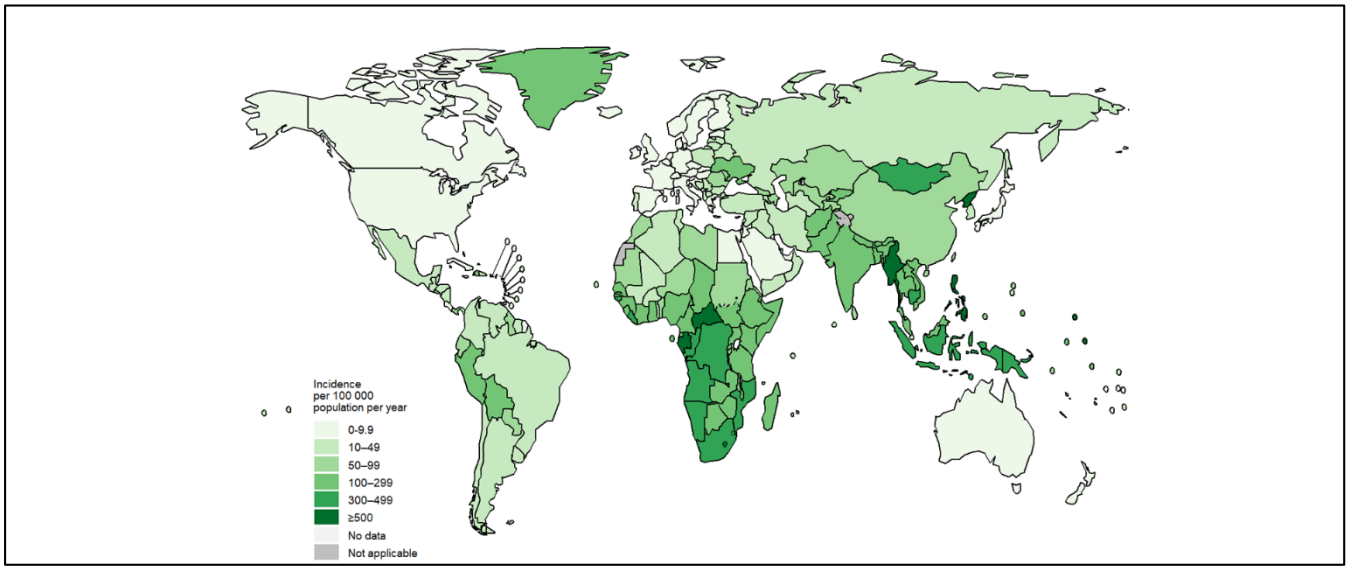

Figure 3. Estimated number of incident TB cases in 2023, for countries with at least 100 000 incident cases (Source: WHO Global Tuberculosis Report 2024)

3.2 Diagnostic Approaches

The diagnosis of tuberculosis has been revolutionized over the past decade by the introduction of molecular diagnostics, though significant gaps remain in the diagnostic cascade, particularly for drug-resistant disease and extrapulmonary manifestations. The traditional mainstays of diagnosis—sputum smear microscopy and chest radiography—remain widely used due to their low cost and broad availability, but their limitations are substantial and well-documented.

Sputum smear microscopy, typically employing Ziehl-Neelsen or auramine-rhodamine staining, detects acid-fast bacilli with moderate sensitivity in cases of cavitary pulmonary tuberculosis but performs poorly in paucibacillary disease, HIV-associated tuberculosis, and extrapulmonary manifestations (Science Direct, 2014). Sensitivity estimates range from 50 to 80 percent for pulmonary tuberculosis in immunocompetent adults, dropping below 20 percent in some HIV-positive populations. The specificity of smear microscopy is also imperfect, as nontuberculous mycobacteria may produce false-positive results, particularly in settings where these organisms are environmentally prevalent. Despite these limitations, smear microscopy retains value for its rapidity, low cost, and utility in monitoring treatment response.

Culture on solid media—traditionally Lowenstein-Jensen or Middlebrook agars—remains the reference standard for tuberculosis diagnosis and drug susceptibility testing. However, the slow growth of M. tuberculosis necessitates incubation periods of two to eight weeks, creating dangerous delays in diagnosis and treatment initiation. Liquid culture systems such as the BACTEC MGIT 960 have reduced time-to-detection to approximately two to three weeks while increasing sensitivity, but require sophisticated laboratory infrastructure and biosafety containment. The development of rapid molecular diagnostics has therefore been prioritized to bridge the gap between clinical suspicion and definitive diagnosis.

The Xpert MTB/RIF assay, introduced in 2010 and subsequently updated to the Xpert MTB/RIF Ultra version, represents a paradigm shift in tuberculosis diagnostics. This automated, cartridge-based nucleic acid amplification test detects M. tuberculosis complex DNA and mutations in the rpoB gene associated with rifampicin resistance within two hours. Large-scale implementation studies have demonstrated sensitivity exceeding 95 percent for smear-positive, culture-positive pulmonary tuberculosis, with lower but clinically useful sensitivity in smear-negative disease. The test requires minimal technical expertise and can be deployed at district-level laboratories or, with appropriate infrastructure, at point-of-care settings. The World Health Organization has recommended Xpert MTB/RIF as the initial diagnostic test for all adults and children with suspected tuberculosis, though global access remains limited by cost and supply chain constraints.

For detection of isoniazid resistance and second-line drug resistance, line probe assays such as the Hain GenoType MTBDRplus and MTBDRsl provide molecular testing on cultured isolates or directly on sputum specimens. These tests identify mutations in resistance-associated genes with high accuracy, enabling rapid selection of appropriate regimens for multidrug-resistant tuberculosis. Whole-genome sequencing is increasingly utilized in reference laboratories, offering comprehensive resistance prediction and epidemiological typing in a single workflow. However, the infrastructure requirements and bioinformatics expertise needed for sequencing limit its availability to well-resourced settings.

The diagnosis of latent tuberculosis infection relies upon immunological assays rather than detection of the organism itself. The tuberculin skin test, in use for over a century, involves intradermal injection of purified protein derivative and measurement of induration after 48 to 72 hours. The test is inexpensive and technically simple but suffers from cross-reactivity with bacille Calmette-Guérin vaccination and nontuberculous mycobacterial infection, as well as reduced sensitivity in immunocompromised individuals. Interferon-gamma release assays, which measure T-cell responses to M. tuberculosis-specific antigens, offer improved specificity and do not require return visits for reading, but are more expensive and may be affected by technical factors in specimen handling. Neither test can distinguish between latent infection and active disease, and neither reliably predicts progression risk in individual patients.

Novel diagnostic approaches under investigation include urine-based lipoarabinomannan detection for HIV-associated tuberculosis, transcriptomic signatures for progression risk stratification, and artificial

intelligence algorithms for automated chest radiograph interpretation. These technologies hold promise for addressing specific diagnostic gaps but require further validation before widespread implementation.

3.3 Therapeutic Strategies

The treatment of drug-susceptible tuberculosis follows standardized regimens established through decades of clinical trials and operational research, while management of drug-resistant disease remains challenging, toxic, and expensive. The fundamental principles of tuberculosis chemotherapy—multiple drugs to prevent resistance, prolonged duration to eradicate persisters, and direct observation to ensure adherence—have remained largely unchanged since the 1970s, though recent trials have questioned some traditional assumptions.

For drug-susceptible pulmonary tuberculosis, the standard regimen consists of six months of therapy with isoniazid, rifampicin, pyrazinamide, and ethambutol for the initial two months, followed by isoniazid and rifampicin for four months. This combination achieves cure in approximately 95 percent of patients who complete therapy, though real-world effectiveness is lower due to treatment interruptions and default (Gillespie et al., 2014). The inclusion of pyrazinamide, active against semi-dormant bacilli in acidic environments, enables the shorter six-month duration that distinguishes modern tuberculosis therapy from the prolonged courses of earlier eras. Ethambutol's role is primarily to prevent the emergence of resistance during the intensive phase, as its early bactericidal activity is modest.

The landmark REMoxTB and RIFAQUIN trials investigated whether fluoroquinolone substitution could shorten treatment to four months without compromising efficacy. Disappointingly, both studies demonstrated inferior outcomes with shorter regimens, leading to the conclusion that four months is insufficient for reliable cure. However, subsequent analyses have suggested that certain subgroups with lower disease severity may be candidates for shortened therapy, and research continues into biomarker-guided treatment individualization (Imperial et al., 2018).

Drug-resistant tuberculosis presents a therapeutic crisis of global proportions. Multidrug-resistant tuberculosis requires treatment with second-line agents for eighteen to twenty-four months, involving daily injections for the initial phase and exposure to drugs with substantial toxicity profiles. Success rates in programmatic conditions hover around 60 percent, compared to over 85 percent for drug-susceptible disease. The cost of treating a single case of multidrug-resistant tuberculosis can exceed ten thousand dollars, compared to less than one hundred dollars for drug-susceptible disease, creating impossible resource constraints in high-burden, low-income settings (van Rensburg et al., 2025).

Management of latent tuberculosis infection has evolved with the recognition that preventive therapy can substantially reduce reactivation risk and contribute to transmission reduction at the population level. Isoniazid monotherapy for six to nine months has been the standard approach, but poor completion rates due to hepatotoxicity and the long duration have limited impact. The introduction of three-month regimens combining isoniazid with rifapentine, administered weekly under direct observation or as self-administered daily therapy,(Alvarez et al., 2025) has improved completion rates and is now preferred for most patient groups. For individuals exposed to isoniazid-resistant tuberculosis, rifampicin monotherapy for four months provides an alternative, though drug-drug interactions with antiretroviral therapy complicate use in HIV-positive populations.

The integration of antiretroviral therapy with tuberculosis treatment in HIV-coinfected patients requires careful attention to pharmacokinetic interactions and immune reconstitution inflammatory syndrome. Rifampicin, a potent inducer of hepatic cytochrome P450 enzymes, substantially reduces concentrations of efavirenz and nevirapine, necessitating dosage adjustments or use of ritonavir-boosted protease inhibitors. The timing of antiretroviral initiation relative to tuberculosis treatment involves balancing the risks of uncontrolled HIV replication against the potential for exacerbated inflammatory responses. Current guidelines recommend early antiretroviral initiation, within two to eight weeks of tuberculosis diagnosis, with the exception of tuberculous meningitis where delayed initiation may reduce neurological complications.

Conclusion

Tuberculosis stands as a testament to the complex interplay between human biology, pathogen evolution, and social structure. Despite remarkable advances in our understanding of Mycobacterium tuberculosis and the development of powerful therapeutic tools, the disease continues to claim over a million lives annually, concentrated among the world's poorest and most marginalized populations. This review has traced the contemporary epidemiology of tuberculosis, highlighting the heterogeneous progress across regions, the challenges posed by drug resistance and HIV coinfection, and the transformative potential of new diagnostic and therapeutic technologies.

The evidence clearly demonstrates that technical solutions alone cannot overcome tuberculosis. The persistence of transmission in high-burden settings reflects fundamental failures of health systems and social protection, not merely the absence of effective interventions. The COVID-19 pandemic has both exacerbated these challenges and created opportunities for systemic reform. As the global health community rebuilds from the pandemic, there is an imperative to integrate tuberculosis services into resilient primary care systems and to address the social determinants that perpetuate vulnerability.

The research and policy priorities are clear: expansion of access to rapid molecular diagnostics and drug susceptibility testing; scale-up of shorter, all-oral regimens for drug-resistant disease; implementation of preventive therapy for high-risk populations; and investment in health system strengthening and social protection. These are not merely technical objectives but moral imperatives. The elimination of tuberculosis by 2030, as envisioned in the Sustainable Development Goals, remains possible but requires unprecedented political commitment and resource mobilization.

Ultimately, the story of tuberculosis is a story of human potential—both the potential of Mycobacterium tuberculosis to exploit conditions of poverty and vulnerability, and the potential of human societies to organize effective responses to shared threats. The coming decade will reveal which potential prevails. The tools are available; what remains is the will to use them equitably and effectively.

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