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OPINION

Relevance of Multidisciplinary Research Fighting Latent/Persistent TB

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Abstract

Latent tuberculosis represents an enormous health, epidemiological, and biotechnological multidisciplinary challenge for the precise identification and control of this infectious disease. Efforts in human and animal infection diagnosis have revealed scientific evidence of shared biomarkers demonstrating the molecular and clinical signs of persistent infection in the natural hosts of the related M. tuberculosis complex bacteria. These findings parallelly potentiate the development of improved tools for identifying and preventing this worldwide persistent disease.

Introduction

Tuberculosis (TB) is still considered a priority public health problem and remains one of the leading causes of mortality from respiratory diseases. TB continues to increase worldwide, and estimates from the World Health Organization (WHO) calculate a global infection rate of 10.4 million cases and 1.7 million deaths per year, with 25% of the total population infected [1].

The standard confirmatory diagnosis of TB is through the culture and isolation of the infectious agent, either *Mycobacterium tuberculosis* (*Mtb*) or *Mycobacterium bovis* (*M. bovis*). The latter is transmitted from bovines to humans and is considered by WHO to be an infectious zoonosis with significant repercussions on public health. Identification of the correct type of pathogen is critical for treatment, *M. bovis* is naturally resistant to pyrazinamide. Human and zoonotic TB are routinely diagnosed by the corresponding intradermal skin test called Tuberculin (TST) which uses complex mycobacterial protein mixtures as an immunological reagent. Although it is a widespread test for epidemiological purposes (not a gold standard), it is inaccurate due to host factors associated with immunologic status (co-infections), co-morbid conditions, previous Calmette Guerin (BCG) vaccination, or different stages of the infection [2].

Improvements in immunological TB assessment are based on blood tests using antigenic stimulus with specific virulence antigen derivatives of

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ancillary laboratory tests (T-SPOT.TB, QuantiFERON® TB GOLD In-Tube). These are ELISA tests, specifically Interferon-Gamma Release Assays (IGRA), based on fresh blood culture stimulus to detect secreted interferon-gamma from memory T-cells in response to specific TB antigens such as ESAT6, CFP10, EspC, and MPB83 (from *Mtb* and *M. bovis* as well) to identify those individuals with an active infection with the *M. tuberculosis* complex [3,4]. Despite the advances in detecting TB, it continues to spread due to the high rate of individuals with asymptomatic or latent infection. After initial infection, progression to active TB typically occurs within two years. Some people may clear the infection, but many do not, and the bacilli remain viable for many years; besides, some people never develop the disease [5]. The disease can manifest in older people or immunosuppressed individuals, and the infection exists in a spectrum of states beyond the current binary classification of latent and active TB [6].

Latent TB is currently detected in humans with immunological analysis using particular protein cocktails supported by clinical, microbiological, and molecular diagnostic tests [7,8], being the basis for the scientific demonstration of the clinical latent state of infection. Zoonotic TB transmission may occur through inhalation of aerosols been observed in workers in the livestock industry [9,10]. Thus, microbiological and immunological evidence of a subclinical bovine TB suggests a latent TB infection in animal hosts as well [11]. Taken together, with some reports of immunosuppressed people who developed a reactivated *M. bovis* infection are evidence of a latent *M. bovis* infection with important implications for the prevalence and distribution of the disease in human and bovine hosts [12].

Tuberculosis cases continue to be significantly prevalent worldwide, with serious economic and public health consequences due to its difficult eradication, driven by an endless infectious cycle in bacterial epidemiology. Both humans and bovines are considered the most susceptible natural hosts and reservoirs of the persistent disease, so scientific studies to improve and update the diagnosis of latent TB in both species have been accumulating and improving. The study of scientific evidence for recognizing persistent infection in humans and cattle has broadened the understanding of TB control. Both species exhibit similar pathological signs, such as the development of granulomatous chronic lesions and comparable immune responses, which have been crucial in identifying the persistent form of TB, contributing to deciphering the silent survival bacterial pattern in asymptomatic hosts [13,14].

In terms of prevention, the BCG (Bacille Calmette-Guérin) vaccine, originally derived from an artificially attenuated strain of *M. bovis* about a century ago, is still administered to humans in endemic countries as a single dose a few days after birth. However, it does not provide long-lasting protection with booster shots. Currently, about a dozen experimental vaccine substitutes are using artificially attenuated (by heat or genetic deletions) immunogenic relatives such as *Mtb*, *M. vaccae* and *M. obuense* strains, been at different clinical trial phases.

They are based on a combination of proteins/cell extracts from selected *Mtb* antigens delivered with adenovirus-originated vectors, nanoparticles, liposomes, and virus-like particles [15]. These promise to be next-generation immunostimulating candidates to combat the disease in immunocompromised people, infants, youth, and adults. Progress in improving prophylactic and therapeutic strategies continues to grow, thanks to relevant biotechnological advances in the field of diagnosis and treatment aimed at targeting pulmonary and chronic TB [16,17].

Although zoonotic TB is more difficult to control due to the lack of strict adherence to health prevention programs for animal disease, animal vaccination against bovine TB is currently being considered in countries that have a greater stake in bovine TB eradication. To date, however, no commercial brands have been released. The effectiveness of BCG in controlling bovine TB remains unclear, but it may slow disease progression reducing early onward transmission. Vaccination studies have benefitted from the introduction of more sensitive and optimized tests that can distinguish between vaccinated and infected animals. These tests, Including the automated test Xpert® *MTB*/RIF Ultra assay for gene amplification of specific DNA fragments (IS6110, IS1081, *rpoB* gene) by real-time PCR and the IGRA for identifying immune biomarkers in bovine tissue and secretory samples, which can be performed antemortem. Biotechnological advancements are currently adapting these tests for practical field applications including protein engineering, technological combinations like Immuno-PCR (I-PCR), and Point-Of-Care (POC) rapid tests [18-24].

Conclusion

It is only a matter of time before there is an effective form of prevention for the eradication of this infectious disease worldwide. The growing international body of multidisciplinary scientific work is generating extensive knowledge for the design of a whole range of improved and innovative biologicals to combat the resilient form of hidden TB infection in an integrative way. Most likely, within this decade, multiple effective and complementary strategies for diagnosing and preventing TB will emerge. These advances will be key in transforming TB into a fully preventable and eradicable disease.

References

1. WHO operational handbook on tuberculosis (Module 1 - Prevention): Tuberculosis preventive treatment. World Health Organization. 2020.
2. Nouira M, Rayana HB, Ennigrou S. How useful is the tuberculin skin test for tuberculosis detection: Assessing diagnostic accuracy metrics through a large Tunisian case-control study. F1000Res. 2024; 1:12:1297. PMID: 39070119; PMCID: PMC11274051.
3. Takwoingi Y, Whitworth H, Rees-Roberts M, Badhan A, Partlett C, Green N, Boakye A, Lambie H, Marongiu L, Jit M, White P, Deeks JJ, Kon OM, Lalvani A. Interferon gamma release assays for diagnostic evaluation of active tuberculosis (IDEA): test accuracy study and economic evaluation. Health Technol Assess. 2019; May;23(23):1-152. doi: 10.3310/hta23230. PMID: 31138395; PMCID: PMC6556820.
4. Gökmen TG, Yakici G, Kalayci Y, Turut N, Ocal MM, Haligür M, Günaydin E, Köksal F. Molecular characterization of Mycobacterium bovis strains isolated from cattle and humans by spoligotyping and 24-locus MIRU-VNTR, and prevalence of positive IGRA in slaughterhouse workers in Southern Turkey. Iran J Vet Res. 2022; 23(3):210-218. doi: 10.22099/IJVR.2022.42580.6186. PMID: 36425601; PMCID: PMC9681978.
5. Chaisson RE, Hopewell PC. Rethinking latent TB? Think again. IJTLD Open. 2024; Aug 1;1(8):335-337. doi: 10.5588/ijtldopen.24.0336. PMID: 39131593; PMCID: PMC11308401.
6. Zaidi SMA, Coussens AK, Seddon JA, Kredo T, Warner D, Houben RMGJ, Esmail H. Beyond latent and active tuberculosis: a scoping review of conceptual frameworks. EClinicalMedicine. 2023; Nov 17:66:102332. doi: 10.1016/j.eclinm.2023.102332. PMID: 38192591; PMCID: PMC10772263.
7. Demissie A, Leyten EM, Abebe M, Wassie L, Aseffa A, Abate G, Fletcher H, Owiafe P, Hill PC, Brookes R, Rook G, Zumla A, Arend SM, Klein M, Ottenhoff THM, Andersen P, Doherty TM, VACSEL Study Group. Recognition of stage-specific mycobacterial antigens differentiates between acute and latent infections with Mycobacterium tuberculosis. Clin Vacc Immunol. 2006; Feb 13(2):179-86. doi: 10.1128/CVI.13.2.179-186.2006. PMID: 16467323; PMCID: PMC1391929.
8. Uzorka JW, Kroft LJM, Bakker JA, van Zwet EW, Huisman E, Prins C, van der Zwanf CJ, Ottenhoff THM, Arend SM. Abnormalities suggestive of latent tuberculosis infection on chest radiography; how specific are they? J Clin Tuberc Other Mycobact Dis. 2019; Jan 25:15:100089. doi: 10.1016/j.jctube.2019.01.004. PMID: 31720416; PMCID: PMC6830153.
9. Torres-Gonzalez P, Soberanis-Ramos O, Martinez-Gamboa A, Chavez-Mazari B, Barrios-Herrera MT, Torres-Rojas M, Cruz-Hervert LP, Garcia-Garcia L, Singh M, Gonzalez-Aguirre A, Ponce de Leon-Garduño A, Sifuentes-Osornio J, Bobadilla-Del-Valle M. Prevalence of latent and active tuberculosis among dairy farm workers exposed to cattle infected by Mycobacterium bovis. PLoS Negl Trop Dis. 2013; Apr 25;7(4):e2177. doi: 10.1371/journal.pntd.0002177. PMID: 23638198; PMCID: PMC3636137.
10. Rodriguez A, Douphrate D, Ruiz de Porras DG, Prot E, Perez A, Hagevoort R, Nonnenmann M. Bovine tuberculosis case intervention using the T.SPOT.TB assay to screen dairy workers in Bailey Country, Texas. Front Public Health. 2020; Sep 2:8:479. doi: 10.3389/fpubh.2020.00479. PMID: 32984254; PMCID: PMC7493632.
11. Alvarez AH, Gutiérrez-Ortega A, Gómez-Entzin V, Pérez-Mayorga G, Naranjo-Bastién J, González-Martínez V, Milián-Suazo F, Martínez-Velázquez M, Herrera-Rodríguez S, Hinojoza-Loza E. Assessment of antigenic supplementation of bovine purified protein derivative for diagnosis of subclinical infection with Mycobacterium bovis in cattle. Microb Pathog. 2017; Jul:108:114-121. doi: 10.1016/j.micpath.2017.05.012. PMID: 28487230.
12. Sotoudeh K, Quon S, Hsieh EP, Donovan J, Chopra S. Disseminated Mycobacterium bovis infection after deceased donor liver transplantation: A case report. Clin Case Rep. 2021; Aug 24;9(8):e04684. doi: 10.1002/ccr3.4684. PMID: 34466246; PMCID: PMC8385254.
13. Salgame P, Geadas C, Collins L, Jones-López E, Ellner JJ. Latent tuberculosis infection--Revisiting and revising concepts. Tuberculosis (Edinb). 2015; Jul;95(4):373-84. doi: 10.1016/j.tube.2015.04.003. PMID: 26038289.
14. Alvarez AH. Revisiting tuberculosis screening: An insight to complementary diagnosis and prospective molecular approaches for the recognition of the dormant TB infection in human and cattle hosts. Microbiol Res. 2021; Nov:252:126853. doi: 10.1016/j.micres.2021.126853. PMID: 34536677.
15. Hoseinpour R, Hasani A, Baradaran B, Abdolalizadeh J, Salehi R, Hasani A, Nabizadeh E, Yekani M, Hasani R, Kafil HS, Azizian K, Memar MY. Tuberculosis vaccine developments and efficient delivery systems: A comprehensive appraisal. Heliyon. 2024; Feb 14;10(4):e26193. doi: 10.1016/j.heliyon.2024.e26193. PMID: 38404880; PMCID: PMC10884459.

16. Patil TS, Deshpande AS. Innovative strategies in the diagnosis and treatment of tuberculosis: a patent review (2014–2017). Expert Opin Ther Pat. 2018; Aug;28(8):615-623. doi: 10.1080/13543776.2018.1508454. PMID: 30084673.

17. Alvarez AH, Flores-Valdez MA. Can immunization with Bacillus Calmette-Guérin be improved for prevention or therapy and elimination of chronic Mycobacterium tuberculosis infection? Expert Rev Vaccines. 2019; Dec;18(12):1219-1227. doi: 10.1080/14760584.2019.1704263. PMID: 31826664.

18. Mehta PK, Dahiya B, Sharma S, Singh N, Dharra R, Thakur Z, Mehta N, Gupta KB, Gupta MC, Chaudhary D. Immuno-PCR, a new technique for the serodiagnosis of tuberculosis. J Microbiol Methods. 2017; Aug:139:218-229. doi: 10.1016/j.mimet.2017.05.009. PMID: 28527886.

19. García JI, Kelley HV, Meléndez J, Alvarez de León RA, Castillo A, Sidiki S, Yusoof KA, Nunes E, López Téllez C, Mejía-Villatoro CR, Ikeda J, García-Basteiro AL, Wang SH, Torrelles JB. Improved alere determine lipoarabinomannan antigen detection test for the diagnosis of human and bovine tuberculosis by manipulating urine and milk. Sci Rep. 2019; Nov 29;9(1):18012. doi: 10.1038/s41598-019-54537-9. PMID: 31784649; PMCID: PMC6884436.

20. Kelley HV, Waibel SM, Sidiki S, Tomatis-Souverbielle C, Scordo JM, Hunt WG, Barr N, Smith R, Silwani SN, Averill JJ, Baer S, Hengesbach J, Yildiz VO, Pan X, Gebreyes WA, Balada-Llasat JM, Wang SH, Torrelles JB. Accuracy of two point-of-care tests for rapid diagnosis of bovine tuberculosis at animal level using non-invasive specimens. Sci Rep. 2020; Mar 25;10(1):5441. doi: 10.1038/s41598-020-62314-2. PMID: 32214170; PMCID: PMC7096388.

21. Hlokwe TM, Mogano RM. Utility of Xpert® MTB/RIF ultra assay in the rapid diagnosis of bovine tuberculosis in wildlife and livestock animals from South Africa. Prev Vet Med. 2020; Apr:177:104980. doi: 10.1016/j.prevetmed.2020.104980. PMID: 32268223.

22. Alonso N, Griffa N, Moyano RD, Mon ML, Colombatti Olivieri MA, Barandiaran S, Martínez Vivot M, Fiorini G, Canal AM, Santangelo MP, Singh M, Romano MI. Development of a lateral flow immunochromatography test for the rapid detection of bovine tuberculosis. J Immunol Methods. 2021; Apr:491:112941. doi: 10.1016/j.jim.2020.112941. PMID: 33321133.

23. Gutiérrez-Ortega A, Moreno DA, Ferrari SA, Espinosa-Andrews H, Ortíz EP, Milián-Suazo F, Alvarez AH. High-yield production of major T-cell ESAT6-CFP10 fusion antigen of M. tuberculosis complex employing codon-optimized synthetic gene. Int J Biol Macromol. 2021; Feb 28:171:82-88. doi: 10.1016/j.ijbiomac.2020.12.179. PMID: 33418045.

24. Mabe L, Muthevhuli M, Thekisoe O, Suleman E. Accuracy of molecular diagnostic assays for detection of Mycobacterium bovis: A systematic review and meta-analysis. Prev Vet Med. 2024; May:226:106190. doi: 10.1016/j.prevetmed.2024.106190. PMID: 38574490.

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