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A Network Analysis Approach to Uncovering Hub Genes in Tuberculosis

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ABSTRACT

Introduction: *Mycobacterium tuberculosis*, the principal cause of tuberculosis, is one of the most common causes of death worldwide. Once the immune system encounters this bacterium, it uses different inflammation pathways to combat it. Inflammatory, anti-inflammatory, and pro-inflammatory pathways are associated with numerous genes, which makes testing them all challenging, costly, and time-consuming. Currently, researchers are interested in discovering the hub genes of this pathway.

Methods and Materials: Based on the literature survey and using the KEGG database, a list of genes involved in pro-inflammatory, inflammatory, and anti-inflammatory pathways was derived from dendritic cells infected with M. tuberculosis strains in Homo sapiens and was used as a KEGGParser plugin in Cytoscape. Centiscape2.2 was then employed to determine these gene networks' degree, betweenness, and closeness. A gene network was then drawn and analyzed using the STRING database.

Results: Several genes were identified as hub genes of pro-inflammatory, inflammatory, and anti-inflammatory pathways. The research successfully identified several hub genes: *IL-6*, *IL1-β*, *IL-12β*, *TNF-α*, *IFN-γ*, and *IL-10*. These genes were highlighted as central to the pro-inflammatory, inflammatory, and anti-inflammatory pathways in dendritic cells infected by *M. tuberculosis*. Each gene plays a significant role in the immune response. IL-6 is known for its dual roles, which promote inflammation. However, it has anti-inflammatory properties too. This duality makes it a critical target for understanding and modulating the immune response in tuberculosis. IL1-β is pivotal in the inflammatory response, helping mediate fever and activate various immune cells. IL-12β is essential for differentiating naive T cells into Th1 cells, and it is crucial for a robust immune response against intracellular pathogens like *M. tuberculosis*. TNF-α, a critical inflammatory mediator, plays a significant role in systemic inflammation and is essential for controlling *M. tuberculosis* infection, though its dysregulation, can lead to detrimental effects. IFN-γ cytokine is central to activating macrophages and promoting antigen presentation, thereby enhancing the host's ability to control *M. tuberculosis* infection. IL-10, an anti-inflammatory cytokine, regulates the immune response to prevent excessive tissue damage during infection.

Conclusion: We found six critical genes involved in the pro-inflammatory, inflammatory, and anti-inflammatory pathways of immature dendritic cells infected with active strains of *M. tuberculosis*.

Keywords: Cytokine, Inflammation, *Mycobacterium tuberculosis*