

Chapter 41

Nanomedicine as a Newly Emerging Approach Against Multidrug-Resistant Tuberculosis (MDR-TB)

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ABSTRACT

Emergence of MDR-TB is highly associated with morbidity and mortality and it needs high concerns about the possibility of a future TB epidemic as limited therapeutic options are available. The current treatment against TB needs daily administration for at least 6 months. That in turn leads to the development and spread of drug-resistant TB. Plenty of work has been done in nanomedicine that provides hope to encounter TB effectively. In the developing world the development of nanoparticle-based aerosol vaccines for tuberculosis has potential applications using on a large scale at relatively low cost, and particularly attractive for use. This book review examines the current TB diagnostic assays and treatment by nanotechnologies and highlight recent advances in Anti-TB Drug (ATD) delivery systems and anti-TB drug encapsulation. It also discusses the impact of the nanoparticles as an emerging treatment against MDR-TB and discusses the current knowledge and potential nanomedicine to improve MDR-TB therapy.

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INTRODUCTION

Tuberculosis (TB) is a treatable and curable bacterial disease that is spread from person to person through the air. Those bacteria that are resistant to at least the two most effective anti-Tuberculosis drugs (ATD), isoniazid and rifampicin can lead to Multidrug-resistant tuberculosis (CDC, 2012). Multidrug-resistant tuberculosis (MDR-TB) can affect persons of any age. Levels of MDR-TB in children are highly variable among countries, but it remains unknown whether children are more or less likely than adults to have MDR-TB due to insufficient data on potential risk factors. Therefore, further research is needed to understand this heterogeneity (Matteo et al., 2013). Most MDR-TB is forms of Rifampicin-resistant tuberculosis (RR-TB) which do not respond to the standard six-month treatment with first-line ATD and can take two years or more to treat. Drug resistance emerges once when TB organisms acquire resistance as a result of inadequate treatment (WHO, 2013).

MDR-TB is a worldwide problem. Because of the global health problems, the increasing rate of MDR-TB and co-infection with HIV are making treatment more challenging. Therefore, there is a need for the development of advanced treatment methods to better control MDR-TB. Conventional treatments typically consist of long-term therapy with a combination of drugs, which may lead to side effects and contribute to low patient compliance (Dipankar et al., 2014).

Epidemiology of Multi Drug Resistant Tuberculosis

Tuberculosis (TB) remains a leading cause of morbidity and mortality worldwide, accounting for nearly 2 million deaths annually (Boonchai et al., 2012). Recent years, emergence of MDR-TB has complicated eradication due to incomplete and inadequate treatment. In 2010, World Health Organization (WHO) reported that 48% of patients with MDR-TB enrolled on treatment were successfully treated. WHO estimated, 3.6% of new tuberculosis (TB) patients in the world have MDR-TB. In 2012, 450,000 incident MDR-TB cases were recorded in the world. The frequency of MDR-TB varies substantially between countries. But the highest prevalent countries are China, India, and the Russian Federation. (WHO, 2013, Yashodhara et al., 2010).

The high global MDR TB prevalence and mortality needs timely DST and improved therapies. Directly observed therapy, short-course (DOTS) is the WHO strategy for worldwide eradication of tuberculosis, and our country achieved 100% coverage for DOTS through the Revised National Tuberculosis Control Program in 2006. For patients with MDR-TB, the WHO recommends a DOTS-Plus treatment strategy. Early detection and prompt treatment of multidrug-resistant tuberculosis is crucial to avoid spread of the disease and also because of the chances of development of potentially incurable extensively drug-resistant tuberculosis (XDR-TB) in these cases. Hence, the standard DOTS regimen may not be helpful for treating these cases. Therefore, MDR-TB cases are difficult to manage and needs prolonged treatment (up to 24 months), high rates of treatment failures, higher costs and potential toxicities of medications. (Yashodhara et al., 2010)

With the support of the EXPAND-TB project, 16 000 people with MDR-TB were detected in India since 2012. This represents 90% of the MDR-TB cases are notified. Between 2009 and 2013, nearly 72 000 people with MDR-TB were detected in the 27 low- and middle-income countries. (WHO 2014).

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