Recent Advances in Nanotechnology based Tubercular Chemotherapy

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ABSTRACT

Tuberculosis (TB) is a more prevalent granulomatous bacterial infection, which remains the world’s second most common cause of death due to infections of Mycobacterium tuberculosis (M.Tuberculosis). A number of characteristics of mycobacterium makes there disease chronic and necessitate prolonged treatment. The emergence of multi-drug-resistance (MDR) stains of M.Tuberculosis makes its necessary for the development of effective combinations of either first-line or second-line drugs or discovery of new effective drug molecules and also implements other modalities of treatment. A number of novel carrier-based drug delivery systems incorporating the traditional and newer anti-tubercular agents have been shown incredible promise to target the site of action, reduce dosing frequency and enhance drug bioavailability with the objective of improving patient compliance. Nanoparticulate system have unique and comparatively more effective drug delivery carriers, including liposomal-mediated drug delivery, polymeric nanoparticles/microparticles, solid lipid nanoparticles, nanosuspensions, nanoemulsions, niosomes, dendrimers, Metal/cyclodextrin inclusion complexes and other nanosystems exploiting the extraordinary properties of matter at the nanoscale. Nanoparticles shown significant improvements in diagnosis, treatment and prevention and provide the flexibility of selecting the invasive and non-invasive route of delivery for chemotherapy of tuberculosis. This manuscript have been made to highlight and overviews the present WHO estimated burden of tuberculosis globally, recent discovery of safe and effective newer anti-tubercular drug molecules for MDR and XDR tuberculosis, first and second line anti-tubercular drugs loaded novel nanoparticle carriers for chemotherapy and development of solid lipid nanoparticles as an alternative drug carriers for tubercular chemotherapy.

KEYWORDS: Tuberculosis, multi-drug-resistance, SLNs, liposomes, polymeric nanoparticles, nanosuspensions, nanoemulsions, niosomes, dendrimers and Metal/cyclodextrin inclusion complexes.

Introduction

Tuberculosis (TB-Tubercle bacillus) is also known as phthisis, phthisis pulmonalis or consumption. TB is a leading chronic disease infected by M. Tuberculosis (Kumar et al., 2007). India is the second most populous country in the world and one-fourth of global incidence TB cases were found annually. In 2012, WHO estimated global annual incidence of 8.6 million TB cases and approx 2.3 million were estimated in India (Fig. 1) (TB annual report, 2014). India’s TB control programme RNTCP (Revised National Tuberculosis Control Programme) has been estimated that 42% reduction in mortality rate, 51% reduction in TB prevalence rate and 19% reduction in TB incidence rate by 2012 as compare to 1990 level (Fig. 2). Globally, WHO estimated 8.6 million people developed TB and 1.3 million died from the disease (including 320000 deaths among HIV-positive people). The number of TB deaths is unacceptably large given that most are preventable. Nearly 20 years after the WHO declaration of TB as a global public health emergency, major progress has been made towards 2015 global targets set within the context of the Millennium Development Goals (MDGs). Two years ahead of the deadline, the Global “Tuberculosis Report 2013” and accompanying supplement “Countdown to 2015” assess progress towards the 2015 targets and the top priority actions needed to achieve and/or move beyond them(Global tuberculosis report, 2013).

Tuberculosis is still major health problem in many developing countries worldwide because of drug resistant TB, as its treatment is longer and requires more expensive drugs. Primary-resistance occurs when a person infected with a resistance stain of TB and the

ABBREVIATIONS: INH: Isoniazid; RIF: Rifampicin; PYZ: Pyrazinamide; EMB: Ethambutol; EE: Entrapment efficiency; CFUs: Colony forming units; PLG: Poly(DL-lactide-co-glycolide); PBCA: poly(butyl-2-cyano-acrylate); MIC: Minimum inhibitory concentration; ATDs: Anti tubercular drugs; MCC-TETA: macrocyclic compound 1,4,8,11-tetraazacyclotetradecane-1,4,8,11-tetra-acetic acid; FRET: Picosecond resolved Förster resonance energy transfer.