Chapter 49
Nanosuspensions in Nanobiomedicine

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ABSTRACT

The tremendous success in developing new nanomaterials and fostering technological innovation arises from the focus on interdisciplinary research and collaboration between physical and medical scientists. The concept of nano-medicine is one of the most important and exciting ideas ever generated by the applications of nanoscience. One of the most challenging tasks in the pharmaceutical industry is the formulation of poorly soluble drugs. The implication of conventional techniques for improving the solubility has gained limited success. Nanoparticles facilitate formulation with improved solubility and efficacy mainly through nanosuspension approach. Techniques such as media milling, high-pressure homogenization, and use of microemulsion have been used for production of nanosuspensions for a novel delivery system. Moreover, they are manoeuvred to patient-acceptable dosage forms like tablets, capsules, and lyophilized powder products. Nanosuspension technology has also been studied for active and passive targeted drug delivery systems, which the chapter highlights on various formulational perspectives and applications as a biomedicine delivery system.

INTRODUCTION

In recent years various technological advances have led to unprecedented improvements in lifestyle, productivity and life span. Moreover there has been a significant burden on global economies and public health as shown by the increases in the outbreak of emerging and re-emerging infectious diseases. Transmission of infectious pathogens to the community has caused outbreaks such as influenza (*A*/*H1N*1 – Swine flu), Dengue fever, Diarrhoea *(Escherichia coli),* Cholera *(Vibrio cholera)* etc throughout the world. Societal changes resulting from mass urbanization (with the mechanisation of agricultural practices and industrialization) and population explosion along with poor water supply and environmental

DOI: 10.4018/978-1-5225-1762-7.ch049

hygiene are the main reasons for the increase in outbreak of infectious pathogens. These events have led to the widespread use of illicit intravenous drugs, which in turn has contributed to the spread of serious blood-borne pathogens like human immunodeficiency virus (HIV) and hepatitis viruses (HBV), and to increased incidence of sub-acute bacterial endocarditis (Hawkey 2008).

The impact of technology on biomedical and clinical practice is among the most valuable changes that have occurred during the twentieth century, notably in the area of prevention and treatment of infectious diseases. The introduction of antibiotics, penicillin (Flemming, 1929) as an antimicrobial agent has pioneered the era of chemotherapy by bringing down the mortality rate with a breakthrough in medicinal field. The different classes of antibiotics that followed served as broad range *wonder drugs* inhibiting the growth of infectious agents by disrupting cell wall synthesis, interfering with DNA replication and protein synthesis (Finberg et al 2004). Furthermore, inappropriate antibiotic usage and inability to produce new antibiotics have introduced extreme selection pressure on bacterial survival. However, the difficulty in identifying the newly proposed crucial bacterial targets by the antibiotics has culminated in the emergence of resistance in the context of antibiotic-mediated stress, an important criterion in bacterial evolution and pathogenesis. The resistance phenomena have several potential mechanisms such as (a) spontaneous / induced mutation, (b) horizontal DNA transfer and (c) alteration of bacterial surface (Figure 1). In addition, bacteria themselves produce a number of antimicrobial products, the most common being the peptide antibiotics. The best studied are the colicins produced by a gram negative bacterium *E. coli* (Riley and Wertz 2002).

The emergence of antibacterial resistance has prompted restrictions on antibacterial use in developed countries like the United Kingdom in 1970 (Swann report 1969), and banning the use of antibacterials as growth-promotional agents by the European Union since 2003. According to US centers for Disease control and Prevention in Atlanta, Georgia drug misuse plays a key factor in the emergence of antibiotic resistance. A survey published earlier this year by the Center for Disease Dynamics, Economics and Policy, found that in developing countries sales of carbapenems ("last resort") increased by nearly six times

Figure 1. The antibacterial resistance pattern exhibited by a bacterium