

medication for their lifetime [13], but limitation and side-effects associated with drugs used for controlling and managing CRD have encouraged us to search for novel treatment [14]. In recent years, advancement in the field of nanotechnology and their role in medicine has led us to develop multifunctional nanoparticles, which can act as nanocarriers for loading different drugs ([15]). These nanocarriers have emerged as a valuable approach for drug delivery with features like prevention of drug degradation, allows the controlled release of the drug, and targeted delivery of the drug at the target site [16].

Therefore this chapter intends to feature the efficacy and physiological aspects of targeted drug delivery, mechanism of pulmonary drug administration. Moreover, it will also emphasize different nanocarriers for drug delivery. Additionally, this will help in gathering deep insight into the challenges and complications associated with developing the pulmonary disease, which will open new avenues for pharmacists with the purpose of minimizing the medical and technical gaps.

This chapter is primarily divided into five sections including the introduction as Section 1. Section 2 describes the background and rationale of the review work envisaged highlighting the global scenario of COPD and anatomy and physiology of lungs to give clear understanding of the underlying mechanism involved in the drug delivery. Section 3 describes the methods and mechanism of drug administration. Section 4 describes about the nanocarrier drug delivery, whereas Section 5 describes about the various drug delivery approaches in controlled pulmonary drug delivery systems along with the clinical studies and challenges associated with controlled drug delivery. Section 6 discusses about the future directions of controlled pulmonary drug delivery systems, and Section 7 provides the concluding remarks.

2. BACKGROUND

2.1. Global Scenario

Millions of people worldwide of all ages are suffering from CRDs such as asthma, COPD, TB and lung cancer. Approximately, 500 million people suffering from these CRDs are from developing nations [17]. In general, CRDs are the diseases associated with airways and different parts of lung. Globally, millions of people are suffering from preventable CRD such as asthma and COPD, out of which 50% of them are from developing countries. And prevalence of these CRD is exponentially increasing especially in children and elder people [18]. The burden induced by these CRDs has adversely affected the lives of many people. In past, the WHO

estimated the death 4.6 million people due to CRDs and also stated that this number will considerably increase in coming future. The major risk factors that have been identified to be responsible for these CRDs includes allergens, air pollution, tobacco smoking, and some disease such as sickle cell anemia and schistosomiasis [19].

Asthma, a prevailing inflammatory disease of airways, is especially linked with hyperresponsiveness of airway organs which causes hindrance in airflow [20]. The most important risk factor of asthma is allergen sensitization. It is also linked with inflammation in nasal mucosa and rhinitis. Both children and adults are highly prone to this disease [21]. Around 300 million people of all cultural backgrounds and ages are suffering from asthma. The two studies, that is, European Community Respiratory Health Survey and the International Study of Asthma and Allergies in Childhood have comprehended the asthma prevalence worldwide [22]. This survey revealed that the global prevalence of asthma has parallelly increased in all countries in relation to allergy. Urbanization and the modern lifestyle are also the factors associated with increasing asthmatic cases. It has been estimated that asthma accord for 250,000 deaths every year globally. Even, prevalence is high in those countries where access to drugs is limited. The disability-adjusted life years have ranked 22nd position to asthma worldwide. The countries such as Australia, Brazil, India, Northern Europe, North America, and some parts of Latin America [23].

COPD, a chronic respiratory disease of airways, which obstructs the airflow during breathing due to inflammatory response to noxious agents such as tobacco smoke, biomass fuel, and industrial contaminants [24]. This disease is highly prevalent in elder people. Globally, COPD has affected approximately 200 million people, out of which 65 million were already suffering from severe respiratory disease. The leading cause of this disease is cigarette smoking which causes damage to lung tissues and obstruct the airway via inflammation and elevated mucus production in bronchi [25]. The clinical symptoms involve breathlessness and cough. As per the prediction by WHO, COPD will attain the 5th position for disability and 3rd position for mortality in 2020 [26]. About 12 Asian countries have been comprehended to be suffering from COPD. Currently the burden of obstructive lung disease is caring out the survey studies in developing countries. The countries such as Australia, Brazil, Denmark, England, Iceland, India, Spain, and the United States are having the high number of COPD patients [27].