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Utilizing Nanotechnology-Based Drug Delivery to Target Eosinophils in Chronic Respiratory Diseases

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Abstract

Major chronic respiratory diseases (CRDs) include asthma, COPD, COVID-19, EGPA, lung cancer, and pneumonia. These diseases are responsible for a significant amount of morbidity and mortality and affect millions of people worldwide. These CRDs are diseases that can't be changed and affect different parts of the respiratory system. They have a big impact on people of all income levels. Eosinophils in the lungs have been linked to an increase in all of these CRDs. Eosinophils are essential immune mediators that play a role in the pathophysiology and homeostasis of various tissues. Interestingly, cellular processes that regulate airway hyper responsiveness, remodeling, mucus hyper secretion, and lung inflammation are linked to an elevated eosinophil level. In eosinophil-mediated lung diseases, therefore, eosinophil is regarded as the therapeutic target. However, conventional treatments for CRDs include bronchodilators, antibiotics, and other anti-inflammatory medications. In any case, the improvement of protection from these remedial specialists after long haul utilization stays a test. However, recent advancements in nanotechnology have revealed the targeted nanocarrier approach, which has the potential to significantly enhance a therapeutic drug's pharmacokinetics. The nanocarrier system has the potential to specifically target eosinophils and the components that are associated with them in order to achieve promising results in the pharmacotherapy of CRDs.

Keywords: Chronic respiratory diseases; Nanotechnology; Drug delivery; Eosinophils

Introduction

Lungs and other respiratory organs are affected by chronic respiratory diseases (CRDs). Asthma, COPD, COVID-19, Eosinophilic granulomatosis with polyangiitis (EGPA), lung cancer, and pneumonia are examples of potentially fatal CRDs. It is said that some of these CRDs are irreparable, meaning they cannot regain normal function; consequently, they are deemed fatal diseases. As indicated by World Wellbeing Association (WHO), 334 million individuals have asthma, and 65 million have COPD, out of which 3 million kick the bucket yearly. Concerning the current pandemic, the World Health Organization (WHO) has stated that approximately one million out of 28.9 million people are susceptible to COVID-19, and this number is exponentially increasing [1,2].

Furthermore, 1.6 million people worldwide have died from lung cancer, which is frequently referred to as the "death disease." Eosinophilic granulomatosis with polyangiitis (EGPA), Loffler's syndrome, and pneumonia were among the other respiratory conditions that showed an elevated level of eosinophils in the blood and lungs. Since eosinophils are immune mediators that collaborate with inflammatory cells to perform a variety of functions, such as maintaining homeostasis and indicating disease conditions in various body tissues and cells, they are an attractive target. Additionally, chronic inflammation is brought on by the secretion of a variety of chemokines, cytokines, proteins, and growth factors by an elevated eosinophil count in the lungs. It can sometimes cause lung tissues to be permanently damaged.

Literature review

Traditional pharmacotherapy, which entails prescribing prescribed doses of a variety of medications, primarily antibiotics, anti-inflammatory agents, bronchodilators, and corticosteroids, has always been the first line of treatment for CRDs. However, these conventional methods are not sufficient to treat these CRDs on their own. Asthma, COPD, and other respiratory diseases, for instance, are treated primarily by reducing the likelihood of exacerbations and treating symptoms. Exposure to allergens, chemical dust, fumes, and cigarette smoke are the most common causes of CRDs. Even though pharmacotherapy suppresses immunological symptoms, it frequently fails to treat multifactorial CRDs like EGPA, pneumonia, and lung cancer [3]. Even though pharmacotherapy methods are important for treating and managing patients throughout their lives, their limitations have pushed us to find new treatments. The significance of nano-drug delivery systems, which have demonstrated promising results in pharmacotherapy, has been made clear by recent advancements in nanotechnology.

Additionally, these nano carriers are able to target the desired location, significantly enhancing the pharmacokinetics of the therapeutic drug. For the treatment of CRDs, the most effective target is now eosinophils. Targeting eosinophils with nanocarrier-based drug delivery systems has the potential to unlock previously unknown therapeutic potentials in the area of interest. Subsequently, this audit expects to give understanding into the job of eosinophils in the treatment of CRDs with the assistance of the nanocarrier drug conveyance framework [4].

Asthma is a chronic, inflammatory disease of the upper airways that typically begins in childhood. In this sickness, the aviation routes get kindled, limited, thickened, and loaded up with bodily fluid, confining wind current. Coughing makes wheezing sounds as a result of this.

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Chest tightness, shortness of breath, coughing, fatigue, wheezing, and conjunctivitis are asthma symptoms [5,6]. Worldwide, nearly 3.39 million cases of asthma and approximately 4.1 million deaths were recorded in 2020. Furthermore, middle- and low-income nations have been implicated in more than 80% of asthma-related deaths. Countries like Great Britain, Australia, Canada, Peru, Brazil, and the United States typically have high asthma prevalence rates, whereas China, Russia, and India typically have low rates.

Despite the similarity of the majority of respiratory conditions, asthma stands out from COPD and other pulmonary diseases due to its distinctive clinical features [7]. Hyper responsiveness of the non-ciliated epithelium in the upper airways, including the bronchi, bronchioles, and trachea, is a component of asthma's pathogenesis. Allergens (pollen, dust particles) and environmental stimuli typically cause this hyper-response of the airway epithelium. Airway remodeling of smooth muscles and goblet cells as a result of this hyper responsiveness results in bronchial constriction, inflammation, and excessive mucus secretion. Eosinophils are frequently linked to significant complications and play a crucial role in hyper responsive reactions [8].

Discussion

Chronic bronchitis and emphysema make up the progressive pulmonary condition known as COPD, which is also known as chronic obstructive pulmonary disease. Emphysema gradually deteriorates the air sacs in the lungs in the early stages of COPD, preventing airflow. Bronchitis, on the other hand, is responsible for the production of mucus plugs as well as the narrowing and thickening of the bronchioles. Around 3.19 million people die annually from COPD, which affects 65 million people worldwide. Between 2.8 and 3.0 million people suffered from COPD in 2015, a significant increase from 2010. As a result, it is listed as the third leading cause of death worldwide. COPD is supposed to be the main source of high mortality and horribleness rates in the following 15 years. When compared to nations like Peru, Abu Dhabi, India, Singapore, Thailand, and others, the United States of America, Austria, Canada, Australia, South Africa, Italy, Uganda, and the United States of America have recorded a higher proportion of COPD patients.

Conclusion

Cigarette and tobacco smoking, toxic airborne particles, and chemical irritants are the primary causes of COPD. Additionally, some genetic factors, such as a lack of -1-antitrypsin, contribute to the deterioration of the lungs. The alveolar wall of the bronchioles is destroyed by the expansion of air spaces, which causes COPD to have a pathological effect on the terminal end of the bronchioles. Further, enactment of eosinophils, primary correction, and irritation in little aviation routes additionally improve the seriousness of the sickness. A cough with or without mucus, weight loss, a wheezing sound, tightness in the chest, and flu-like symptoms are all signs of COPD.

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Conflict of Interest

None

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