WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
SJIF Impact Factor 8.084
Volume 13, Issue 3, 674-691. Review Article ISSN 2277–7105

A REVIEW ON NANOPARTICLES THE MAGIC BULLET CONCEPT FOR THE TREATMENT OF CHRONIC PULMONARY DISEASE

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Article Received on
15 December 2023,

Revised on 05 Jan. 2024,
Accepted on 25 Jan. 2024

DOI: 10.20959/wjpr20243-31228

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ABSTRACT

Chronic pulmonary diseases, encompassing conditions such as chronic obstructive pulmonary disease (COPD), pose significant challenges in their treatment due to the complex nature of the lungs and the need for targeted medication delivery. Nanoparticles face challenges for targeted and controlled drug release within the lungs. This review explores the potential of nanoparticle-based drug delivery systems as the "magic bullet" for treating chronic pulmonary diseases. In the context of lung diseases like chronic obstructive pulmonary disease (COPD) and Asthma, a magic bullet treatment would ideally be a medication that precisely targets the underlying cause or mechanism of the disease, providing significant relief or a cure without causing adverse effects or impacting healthy tissues. NPs have the potential to be effective drug carriers when combined with targeting ligands and possess many of the properties of a miracle cure. The term "miracle cure" originates aimed only at killing parasites in the body and ultimately has minimal negative effects on the human body. The drug's ability to harm multiple targets makes it a "magic shotgun" rather than a silver bullet. There is still a long way to go to achieve this miraculous goal. Nanoparticles can protect drugs from degradation, improve their solubility, and enable controlled release, ensuring efficient drug delivery to specific lung regions. Understanding the design, properties, and challenges associated with these innovative systems is crucial for advancing the development of effective therapies for chronic pulmonary diseases, offering hope for improved patient outcomes and enhanced quality of life.

KEYWORDS: Nanoparticle-based drug delivery, Chronic pulmonary disease, Pulmonary drug delivery, Magic bullet concept.

INTRODUCTION

Chronic lung disease includes a variety of persistent lung disorders, such as asthma, chronic obstructive pulmonary disease (COPD), cystic fibrosis, tuberculosis, idiopathic pulmonary fibrosis (IPF), and lung cancer. Some of these diseases are incurable and often fatal, and no treatment is effective in fully restoring lung function. Currently, an estimated 300 million and 210 million people worldwide suffer from the two most common diseases, asthma and COPD.[1] Among the various delivery systems or strategies, pulmonary drug delivery offers unique advantages such as no first-pass effect and high bioavailability, which can directly deliver the drug. Chronic Pulmonary Disease (CPD) poses a significant health challenge globally, impacting millions of lives with its complex and debilitating effects on respiratory function. The intricacies involved in treating CPD, encompassing conditions like COPD and asthma, have long demanded innovative solutions that provide targeted and effective delivery of therapeutic agents to the affected regions of the lungs. Enter the world of Nanoparticle-Based Drug Delivery Systems—an extraordinary avenue that holds the potential to revolutionize CPD treatment. Within this cutting-edge realm, nanoparticles serve as microscopic carriers, capable of encapsulating drugs and navigating the intricate pathways of the respiratory system to precisely reach and treat the affected pulmonary sites. Termed the "magic bullet" in medical sciences, these nanoparticles offer a beacon of hope by enabling the delivery of medications directly to the diseased areas, optimizing treatment efficacy while minimizing systemic side effects.[2] The development of novel nanoparticle-based drug delivery systems, capable of targeting specific cells such as lung epithelial cells and macrophages, while minimizing systemic side effects is currently underway, has received special attention. These systems use nanoparticles, which are tiny particles ranging in size from 1 to 100 nanometers, to encapsulate and deliver drugs directly to affected areas of the lungs. By modifying the surface properties of nanoparticles, researchers can improve their ability to selectively bind to specific cell types in the lungs, thereby improving drug delivery efficiency and reducing side effects. Off-target use. In addition, nanoparticle-based drug delivery systems can protect drugs from degradation and improve their stability, thereby ensuring sustained drug release and prolonging the therapeutic effect.[1]

Pulmonary system

Anatomy & physiology human organ of gas exchange the lungs are located in the chest, where their delicate tissues are protected by the skeleton and rib muscles. The lungs provide the tissues of the human body with a constant flow of oxygen and remove waste carbon dioxide from the blood. Atmospheric air is pumped regularly through a system of pipes, called airways, that connect the gas exchange zone to the outside of the body. The respiratory tract can be divided into the upper and lower respiratory systems. The transition between the two systems is at the intersection of the respiratory and digestive systems, right above the larynx.[3]

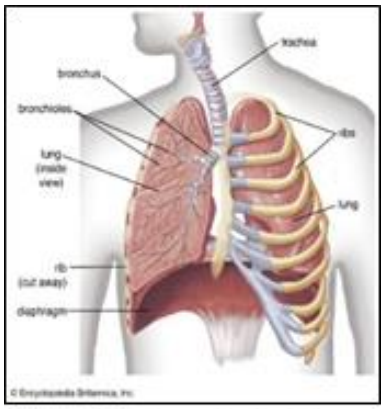

Figure 1: Anatomy & physiology

RESPIRATORY MECHANICS

The respiratory system is responsible for the exchange of gases, primarily oxygen and carbon dioxide, between the body and the external environment. This process includes both mechanical and biochemical components and is essential for cellular respiration, where cells use oxygen to generate energy. The lungs resemble inflatable balloons that are actively inflated by positive and/or negative pressure within the pleural cavity. During normal breathing, negative pleural pressure (Ppl) is sufficient to inflate the lungs during the inspiratory phase. Understanding the pressure of expansion is critical to understanding how breathing works. Inflation pressure is called transpulmonary pressure (Ptp) and is expressed as:

Ptp = Paw−Ppl, (Ptp = transpulmonary pressure, Paw = alveolar pressure, Ppl = Pleural pressure).[4]

Pulmonary Disease

Chronic respiratory diseases are long-term health conditions that affect a person's ability to breathe. This condition makes it difficult for the lungs to get enough air, which can cause symptoms such as shortness of breath, coughing, and wheezing. Common examples of chronic respiratory diseases include asthma, chronic obstructive pulmonary disease (COPD), and bronchitis. These conditions often require ongoing medical care and can affect a person's quality of life.

COPD

Chronic obstructive pulmonary disease (COPD) is a progressive chronic inflammatory lung disease characterized by persistent airflow limitation. The term "obstructive" in COPD refers to airflow restriction due to partial or complete obstruction of the airway. COPD is a multifactorial disease that is both preventable and treatable. It is currently the fourth leading cause of death worldwide and is predicted to become the third leading cause of death by 2020. Globally, the burden of the disease is expected to increase in the coming decades due to the continued burden of COPD risk factors and an aging population.[5] Distinct symptoms commonly reported by COPD patients include coughing, sputum production, wheezing, and shortness of breath. However, the impact of symptoms on an individual patient's activities of daily living depends on many factors, including disease severity and comorbidities.[6] Exacerbations of COPD are associated with increased upper and lower respiratory tract disease and systemic inflammation (Figure 2). Because it is difficult to perform a bronchial biopsy during an exacerbation to severe COPD in patients with moderate disease, there is little information about the nature of inflammatory changes in the airways, especially when examined near the exacerbation. In stable COPD, there is an increase in CD8+ lymphocytes and macrophages in the bronchial mucosa, and in more severe disease, there is an increase in neutrophils.[7] However, pharmacotherapy for COPD has improved significantly over the past decade. The availability of long-acting beta-agonists (LABA), fixed combinations of inhaled corticosteroids and LABA, and long-acting anticholinergic or muscarinic antagonists (LAMA) has previously significantly better outcomes were possible. Exacerbations are thought to be associated with a decrease in FEV1 and all of the above drugs reduce exacerbation rates, so an impact on disease progression is expected.[8]

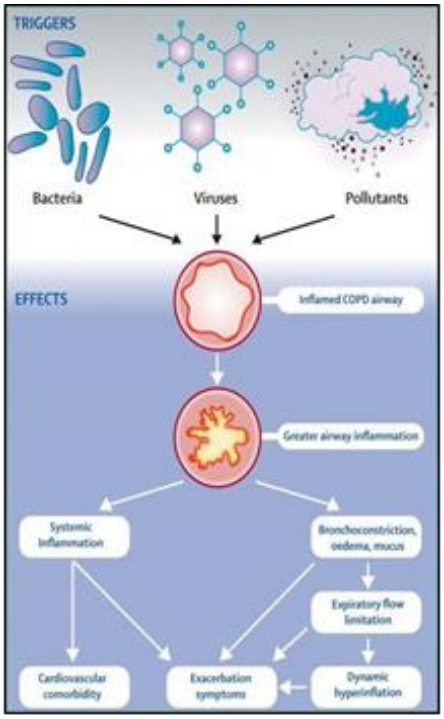

Figure 2 : Mechanism Of COPD

Asthma

The World Health Organization (WHO) defines asthma as a chronic inflammatory disease of the airways characterized by wheezing, shortness of breath, chest tightness, and repeated coughing. Asthma affects approximately 300 million people worldwide and causes 1 in 250 deaths worldwide. Approximately 12 million people in the United States experience an acute asthma exacerbation each year, and a quarter of them require hospitalization. Acute asthma must be distinguished from poorly controlled asthma. Patients with acute asthma increasingly experience shortness of breath, chest tightness, coughing, and/or wheezing. In contrast, poorly controlled asthma usually results in diurnal fluctuations in airflow, a feature that does not usually occur during acute exacerbations.[9] Asthma is associated with T helper cell type 2 (Th2) immune responses typical of other atopic diseases. Asthma triggers include allergic stimuli (such as dust mites, cockroach debris, animal dander, mold, and pollen) and non-allergic stimuli (such as viral infections, exposure to cigarette smoke, cold air, and exercise) that set off a series of events. It is included. Causes chronic airway inflammation. Increased levels of Th2 cells in the airways result in the release of specific cytokines, such as interleukin (IL)-4, IL-5, IL-9, and IL-13, which promote eosinophilic inflammation and immunoglobulin E (IgE) production is stimulated. IgE production, in turn, triggers the release of inflammatory mediators such as histamine and cysteinyl leukotrienes, leading to

bronchospasm (contraction of airway smooth muscle), edema, and increased mucus secretion, leading to the characteristic symptoms of asthma.[10] Treatment of persistent asthma requires avoidance of aggravating environmental factors, use of short-acting β2-agonists for rapid symptom relief, and daily use of inhaled corticosteroids. Moderate and severe asthma may require other management medications such as long-acting bronchodilators or biologics. People with severe asthma generally benefit from consulting an asthma specialist to consider additional treatments, such as biologic injections.[11]

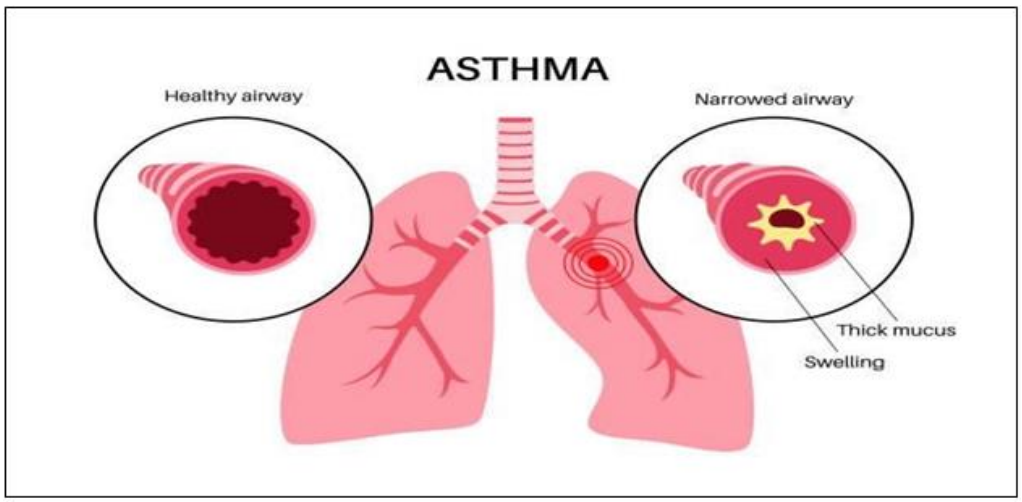

Figure 3 : Asthma

Nanoparticle In Drug Delivery System

Nanoparticles in drug delivery systems are very small particles, typically in the size range of 1 to 100 nanometers, designed to deliver therapeutic agents (such as drugs or genes) to specific cells, tissues, or organs in the body. The field of nanomedicine is the use of the unique properties of nanoparticles to improve the effectiveness and reduce side effects of various drugs. Nanomedicine and Nano delivery systems are relatively new but rapidly evolving sciences in which nanoscale materials can serve as diagnostic tools or deliver therapeutic agents to specific target sites in a controlled manner used to. Nanotechnology offers many advantages in the treatment of chronic human diseases through site-specific, targeted, and precise drug delivery.[12] Nanoparticles are distinguished by their high stability, high specificity, high drug delivery capacity, controlled release capability, possibility of use in various drug delivery modes, and ability to transport both hydrophilic and hydrophobic properties. It can offer significant advantages over traditional drug delivery mechanisms. Molecules can be encapsulated within the nanoparticle spheres or attached to the surface. Once at the target site, the drug cargo is released from the nanoparticle through diffusion,

swelling, erosion, or degradation. Active systems are also possible, e.g., Releasing drugs in response to external energy inputs such as targeted ultrasound, light, or magnetic fields.[13]

Types of Nanoparticle In Drug Delivery System

Due to its unique properties such as small size, large surface area, and tunable surface properties, it has attracted great attention in drug delivery systems. They can be designed to encapsulate drugs, protect them from degradation, and target specific tissues and cells. Here are some common types of nanoparticles used in drug delivery systems.

- **Polymeric nanoparticles (polymer-drug conjugates)**

The concept of polymer-drug conjugates was first introduced by Helmut Ringsdorf in 1975. According to this concept, an ideal polymer-drug conjugate is characterized by a hydrophilic polymer backbone as a vehicle and a bioactive drug attached to the polymer scaffold, usually through a biologically reactive linker. In some cases, targeting moieties or solubility enhancers can also be introduced into the conjugate to improve pharmacokinetic behavior and therapeutic efficacy. In general, polymer-drug conjugates are used as drug delivery devices for 1) the ability to achieve high drug payloads, 2) enhanced drug solubility, and 3) modulation of drug pharmacokinetics, such as prolonged plasma exposure or optimized It offers several advantages, including improved biodistribution behavior. Improvement of therapeutic effects, etc.[14]

- **Polymeric micelles**

Drug delivery using micellar solutions of amphiphiles is an effective method for targeted drug delivery. Due to the hydrophobic environment of the micellar core, water-insoluble drugs can be easily solubilized and incorporated for delivery to the desired target. Targeted drug delivery systems are designed to minimize drug degradation and loss, prevent harmful side effects, increase drug bioavailability, and increase the amount of drug in the desired target area. A variety of drug carriers are widely used, including soluble polymers, insoluble natural and synthetic polymers, microparticles, cells, cell ghosts, lipoproteins, liposomes, and micelle systems based on amphiphilic polymers.[15]

- **Dendrimers**

Dendrimers are highly branched three-dimensional macromolecules with highly controlled structures, single molecular weights, numerous controllable "peripheral" features, and a tendency to become spherical above a certain size. These properties make them particularly

attractive for applications in pharmaceuticals and medicinal chemistry. The well-defined structure, compact spherical shape, monodispersed in size, and controllable "surface" functionality of dendrimers make them excellent candidates for evaluation as drug carriers.[16]

- **Liposomes**

Liposomes are the most widely used and well-studied nanocarriers for targeted drug delivery. They improve therapeutics for a variety of biomedical applications by stabilizing therapeutic compounds, overcoming barriers to cellular and tissue uptake, and improving biodistribution of compounds to target sites in vivo. I've been doing it. Liposomes are defined as phospholipid vesicles composed of one or more concentric lipid bilayers surrounding a distinct aqueous space. The unique ability of liposome systems to entrap both lipophilic and hydrophilic compounds enables the encapsulation of a variety of drugs by these vesicles. Hydrophobic molecules are inserted into the bilayer membrane, and hydrophilic molecules are trapped in the aqueous center.[17]

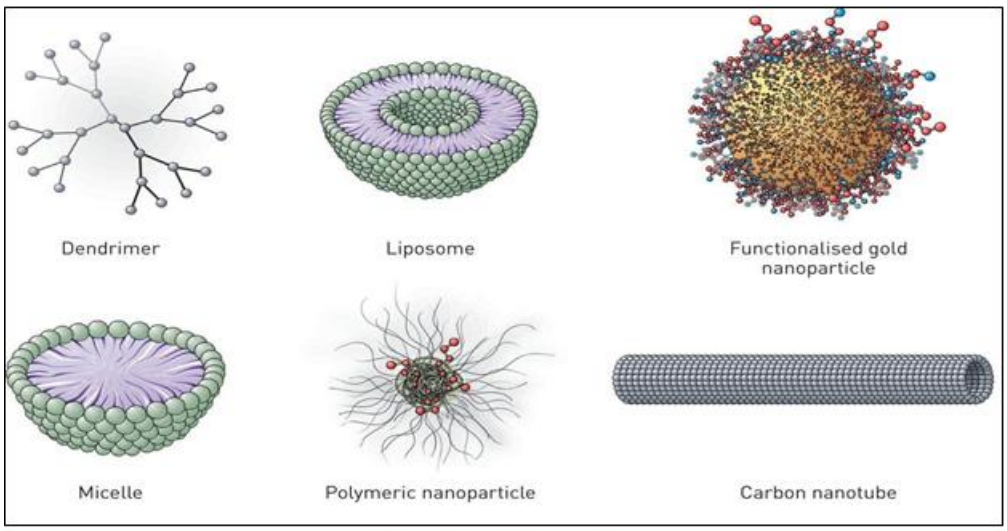

Figure 4: Types Of Nanoparticle

- **Viral nanoparticles**

Viral nanoparticles (VNPs) include a variety of natural nanomaterials derived from plant viruses, bacteriophages, and mammalian viruses .The nanomedicine applications and development of VNPs and their genome-free version, virus-like particles (VLPs), are rapidly increasing. VLPs encapsulate a wide range of drugs and are genetically or chemically linked to targeting ligands to achieve tissue specificity. VLPs are produced through scalable fermentation or molecular agriculture, and the materials are biocompatible and biodegradable. These properties have led to a variety of applications, including cancer

therapy, immunotherapy, vaccines, antibacterial therapy, cardiovascular therapy, gene therapy, and diagnostic imaging and therapeutics.[18]

- **Carbon nanotubes**

Carbon nanotubes (CNTs) are one of the unique and desirable discoveries in the field of nanotechnology. Since their invention by researcher Iijima in 1991, CNTs have attracted great interest in many pharmaceutical and engineering fields due to their small size, light weight, high tensile strength, and good electrical conductivity. CNTs are the most sophisticated materials human researchers have ever worked with. They are graphitic in nature and exhibit sp2 hybridization. Due to its unique structure, there are three classes of : SWCNT, DWCNT, and MWCNT. CNTs are manufactured using various methods such as arc discharge, laser ablation, and chemical vapor deposition. CNTs are used in a variety of applications due to their unique properties such as mechanical, thermal, electrical, and optical properties. They are used in applications such as biomedicine, drug delivery systems, sensors, implants, tissue engineering, and cancer therapy.[19]

Types of Nanoparticle for drug delivery			
System	**Structure**	**Characteristics**	**Examples of compounds**
Polymeric nanoparticles (polymer-drug conjugates)	Drugs are conjugated to the side chain of a linear polymer with a linker (cleavable bond)	(a) Water-soluble, nontoxic, biodegradable (b) Surface modification (pegylation) (c) Selective accumulation and retention in tumor tissue (EPR effect) (d) Specific targeting of cancer cells while sparing normal cells—receptor-mediated targeting with a ligand	Albumin-Taxol (Abraxane) PGA-Taxol (Xyotax) PGA-Camptothecin (CT-2106) HPMA-DOX (PK1) HPMA-DOX-galactosamine (PK2)
Polymeric micelles	Amphiphilic block copolymers assemble and form a micelle with a hydrophobic core and hydrophilic shell	(a) Suitable carrier for water-insoluble drug (b) Biocompatible, self-assembling, biodegradable (c) Ease of functional modification (d) Targeting potential	PEG-pluronic-DOX PEG-PAA-DOX (NK911) PEG-PLA-Taxol (Genexol-PM)
Dendrimers	Radially emerging hyperbranched synthetic polymer with regular pattern and repeated units	(a) Biodistribution and PK can be tuned (b) High structural and chemical homogeneity (c) Ease of functionalization,	PAMAM-MTX PAMAM-platinate

		high ligand density (d) Controlled degradation (e) Multifunctionality	
Liposomes	Self-assembling closed colloidal structures composed of lipid bilayers	(a) Amphiphilic, biocompatible (b) Ease of modification (c) Targeting potential	Pegylated liposomal DOX (Doxil) Non-pegylated liposomal DOX (Myocet) Liposomal daunorubicin (DaunoXome)
Viral nanoparticles	Protein cages, which are multivalent, self-assembled structures	(a) Surface modification by mutagenesis or bioconjugation—multivalency (b) Specific tumor targeting, multifunctionality (c) Defined geometry and remarkable uniformity (d) Biological compatibility and inert nature	HSP-DOX CPMV-DOX
Carbon nanotubes	Carbon cylinders composed of benzene ring	(a) Water-soluble and biocompatible through chemical modification (organic functionalization) (b) Multifunctionality	CNT-MTX CNT-amphotericin B
Abbreviations: PGA, poly-(L-glutamate); HPMA, N-(2-hydroxypropyl)-methacrylamide copolymer; PEG, polyethylene glycol; PAA, poly-(Laspartate); PLA, poly-(L-lactide); PAMAM, poly(amidoamine); DOX, doxorubicin; MTX, methotrexate; PK, pharmacokinetics; EPR, enhanced permeability and retention; CNT, carbon nanotube; HSP, heat shock protein; CPMV, cowpea mosaic virus.[20]			

The Concept Of Magic Bullet

The term "Magic Bullet" in drug delivery refers to the targeted delivery of therapeutic agents to specific locations within the body, often using nanoparticles as carriers. In the treatment of chronic lung diseases, nanoparticle-based drug delivery systems offer several advantages, such as improving drug efficacy, reducing side effects, and specifically targeting affected areas of the lung. `Magic Bullet" Concept The idea of directing drugs to their site of action dates back to the theory of the ``Magic Bullet" concept. Paul Ehrlich originally proposed the idea of using a "magic bullet" to fight disease while sparing the host organism. That was a century ago. Cancer treatment experts were particularly enthusiastic about the concept. Ehrlich approached his "miracle weapon" idea in his two steps. He first checked for harmful drugs and then modified those drugs to make them less harmful and more targeted. He had a clear idea of how stress-free it would be if diseases could be treated using only compounds specifically related to the causative microorganism. There are no obligations to the host. The term "miracle cure" originates from the fact that it is aimed only at killing parasites in the

body and ultimately has minimal negative effects on the human body. Erlich predicted that site-specific treatment would be more beneficial than learning how to use a magic bullet, since an archer's magic bullet would only hit the enemy. This intriguing concept led scientists to further research for almost a century, leading to the discovery of several nanoscale devices that are now known as nanomedicines."13 The fact that this idea works is a strong indication that it is attractive, but delivering miracle cures to clinics remains difficult. Achieving the ideal goal of Tebabe Dovepress is designed to develop therapies that effectively treat a given disease state and that stably target the disease without causing immunogenicity or specific interactions. Identify strategies to deliver drugs to the site. NPs have the potential to be effective drug carriers when combined with targeting ligands and possess many of the properties of a miracle cure. Ehrlich's ``magic bullet'' The theory states that drugs should interact with target molecules in the body only after reaching their intended destination. However, drugs come into contact with the body through complex routes during transport. Although the goal was achieved, interactions between multiple targets may occur and side effects may occur. Unfortunately, there are still no drugs or ADDS that have directly achieved physical goals without these interactions. The drug's ability to harm multiple targets makes it a "magic shotgun" rather than a silver bullet. There is still a long way to go to achieve this miraculous goal.[23]

Nanocarriers for targeted therapy

NPs can enhance the pharmacokinetics and pharmacodynamics profiles. Moreover, NPs can beautify intravenous management of capsules, and maximize drug balance to reduce degradation. Facile amendment of the surfaces of NPs cause them to powerful vendors for focused on sickness sites. In this regard choice of unique capsules and nanocarriers are essential for attaining the goals of focused drug shipping. Moreover, focused on a drug to a particular diseased, we it's miles essential to recognize the character of nanomedicine, its biocompatibility, and capacity of passing via the organic barrier and launch of drug on the focused quarter of action. Several studies groups have investigated that how length and form of nanocarriers affect their mobile uptake in drug shipping systems.[24] Active focused on refers to ligand-receptor interplay after nanoparticles attain the focused through systemic circulate. Ligand-receptor interplay is viable most effective if the 2 additives are in near proximity (< 0.5 nm). Active focused on in tumors may be done via way of means of functionalizing the nanoparticles with proteins, peptides, nucleic acid aptamers, carbohydrates, and different small molecules. Several trainings of substances had been

evolved so far for focused therapy, which include biodegradable polymers, liposomes, dendrimers, nano shells and nucleic acid-primarily based totally NPs. In most cancers therapy, biodegradable nanoparticles are notably applied because of their excessive biocompatibility. In focused shipping, sustained launch and -unique shipping are the high requirements. Another essential issue is the stableness of nanoparticles for longer retention in blood circulate and ultimately accumulation in tumors.

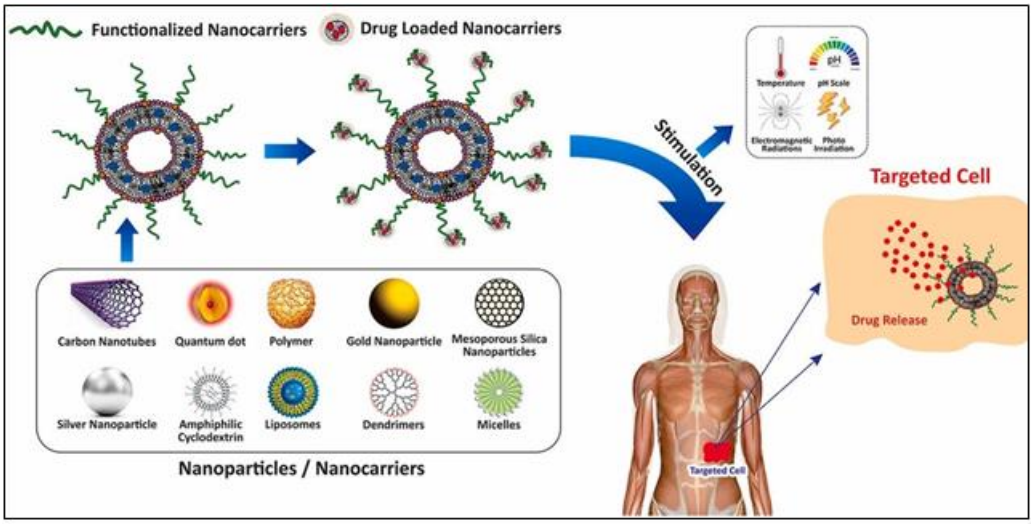

Figure 5 : Nanocarrier for targeted drug therapy

A well-known type of 2D nanocarrier, layered double hydroxides, a well-known type of 2D nanocarriers, have attracted attention for their potential as drug carriers due to their high drug loading capacity, biocompatibility, and anion exchange ability. The internal and external surfaces of layered double hydroxides (LDHs) can be easily modified to incorporate targeting ligands and have a high specific surface area, making them advantageous for various applications. Sudipta prepared a series of magnesium and aluminum LDHs by anion exchange method and added raloxifene hydrochloride, a potent anticancer agent. Controlled drug release and higher cytotoxicity were observed in HeLa cells, which was further confirmed by in vivo tumor inhibition in a mouse model, indicating its application as a drug delivery vehicle. Polymer nanoparticles can be formulated to encapsulate a variety of hydrophilic and hydrophobic small molecules, especially drugs and macromolecules such as proteins and peptides. Drug release from these nanoparticles can be controlled in a time-dependent manner via diffusion or swelling followed by diffusion or mass erosion. Release rates can be controlled by polymer modification, new polymer development, or copolymer synthesis. The main advantage of these biodegradable polymers is that they maintain drug concentrations in the optimal range for long periods of time, increasing drug efficacy and

improving patient compliance. Therefore, targeted therapy combines targeted administration with sustained release of the drug, which allows for maximum utilization of the drug delivered to the tumor site.[25]

Nanomedicine In Chronic Respiratory Diseases

Chronic lung diseases such as COPD, asthma, and interstitial pulmonary fibrosis cause more health problems and deaths. When treating these diseases, administering drugs directly to the lungs has advantages over administering drugs systemically. Many lung diseases cause swelling. Changes in the structure of the lungs and the body's response to swelling make breathing more difficult for patients with chronic asthma and his COPD. Researchers tested its effectiveness against microparticles and animals. Some studies have shown positive results. In one study, nanoparticles loaded with a substance called recombinant Caryota mitis profilin were tested in mice with asthma. These particles help balance the immune system and were effective in treating asthma in mice. Another study looked at the effects of silver nanoparticles on lung inflammation and breathing problems in asthmatic mice caused by a protein called ovalbumin. The silver nanoparticles reduced swelling and allowed the mice to breathe easier. Studies have also been conducted using curcumin nanoparticles in rats with asthma. Curcumin nanoparticles were better at reducing swelling and improving breathing than curcumin alone. The 4,444 scientists also investigated how well different nanoparticles reached the lungs using dry powder inhalers. They studied how liposomes, tiny fat bubbles, release a drug called salbutamol sulfate (SBS) in rats and guinea pigs with asthma. Liposomes containing SBS remained in the lungs longer and were more effective than SBS solution alone, especially in guinea pigs. One study looked at treatments aimed at inhibiting the growth of new blood vessels in the lungs, a hallmark of asthma. A special treatment of rats with allergic asthma was shown to reduce blood vessel growth and show respiratory problems. In another study, microparticles of chitosan and alginate, substances that adhere to surfaces, were tested in a model that mimics the inflammatory lung disease caused by cigarette smoke. These particles were more effective at controlling inflammation than the drug alone. However, the use of nanoparticles in therapy can cause allergic inflammation and asthma, so it is important to study these risks carefully Overall, these studies suggest that the use of microparticles may be beneficial in lung disease, but further research is needed to fully understand their safety and efficacy.[21]

Nanomedicine in Asthma

Asthma is the most common long-term inflammatory disease of the lungs, characterized by intermittent reversible airway obstruction, bronchial hyperresponsiveness, and chronic airway inflammation. The electronic nose (E-Nose) is a new device consisting of nanosensors that can detect certain volatile organic compounds (VOCs) in exhaled gases. In general, the main advantage of breath analysis technology such as E-Nose is the non-invasive diagnosis of various diseases Better than other commonly used methods. Previous clinical studies have shown that the E-Nose method can differentiate the exhaled breath of asthma patients from healthy controls and make a difference in asthma severity. This was the first study in the field of asthma to use pattern analysis of VOC mixtures exhaled through an electronic nose. E-Nose technology is also used to detect and differentiate lung diseases. Asthma has four well-described inflammatory phenotypes, including eosinophilic, neutrophilic, and oligogranulocytic, which are classified based on the number of inflammatory cells induced in the sputum. Inflammatory asthma phenotypes have been shown to differ in airway microbiology and even in response to corticosteroid treatment. Diagnosis of the asthma phenotype is therefore important for a personalized approach to asthma treatment. Recently, highly accurate non-invasive assessment methods have been developed using nanotechnology to differentiate between patients with eosinophilic, neutrophilic, and oligogranulocytic asthma phenotypes. The results of a clinical study conducted to evaluate the performance of this method show that different phenotypes of inflammatory asthma can be easily distinguished from respiratory prints based on induced sputum analysis using the E-Nose device. I did. Nanomedicine has also been used to deliver therapeutics to treat asthma. Salbutamol is a bronchodilator used to relieve symptoms and prevent bronchoconstriction. However, insufficient deposition of inhaled drugs into the lungs poses a continuing and continuing challenge to the relief and control of asthma symptoms demonstrated a reduction in drug levels and a 2.3 fold increase in total lung deposition in healthy subjects after dry powder inhalation compared to standard microparticle formulations used for dry powder inhalation. In another nanoformulation of salbutamol studied clinically, the drug was encapsulated in nanometer-sized vesicles based on nonionic surfactants (niosomes). Preclinical studies demonstrated controlled release of the drug over an 8-hour period Phase I clinical trials are currently underway to investigate the relative bioavailability of this nanosalbutamol and sustained release of the drug after inhalation. One of these studies subcutaneously immunized mice with polymeric poly (lactic-glycolic acid) nanoparticles containing recombinant birch profilin protein, an allergen found in pollen, latex, and plant

foods. investigated the use of nanotherapeutics to treat allergic asthma. In a mouse model of allergic asthma, this therapeutic strategy was found to have preventive and therapeutic effects by modulating the Th1/Th2 balance.[22]

Nanomedicine in COPD

COPD, like most chronic non-communicable diseases, is the third leading cause of death worldwide. It has been pointed out that diagnosing COPD early may change the rate of disease progression and the severity of lung dysfunction. Spirometry is the gold standard method for diagnosing his COPD and monitoring its progress, and its implementation and evaluation requires an experienced operator and general practitioner. Additionally, dyspnea may not be clinically apparent in the early stages of his COPD. In previous studies, a nanosensor-based e-nose method diagnosed COPD and confirmed COPD patients with asthma (96% accuracy) and lung cancer and her COPD (85% accuracy). A recent clinical trial used the e-nose method to identify bacterial colonization in COPD patients and compared it with quantitative culture of protected sample brushes. This is a gold standard, but invasive method for diagnosing distal respiratory tract infections. This study found the E-Nose method to be 88% effective in distinguishing between colonized and non-colonized patients with COPD. However, they have similar demographics, features, etc. In this study, the E-Nose tool was presented as a non-invasive, user-friendly, practical and reliable method to detect bacterial colonization in COPD patients.[22]

SUMMARY

In summary, nanoparticle-based drug delivery systems show real potential in treating chronic lung diseases. They act like a "magic bullet," precisely targeting affected areas in the lungs while reducing side effects elsewhere in the body. These tiny particles can carry drugs to specific places, making treatments more effective and reducing how often they need to be taken. This review explores the potential of nanoparticle-based drug delivery systems as the "magic bullet" for treating chronic pulmonary diseases. In the context of lung diseases like chronic obstructive pulmonary disease (COPD) and Asthma, Asthma presents recurrent airway inflammation causing breathing difficulties triggered by various factors, whereas COPD involves chronic airflow limitation, primarily associated with smoking or environmental exposures, leading to breathing challenges and persistent cough. a magic bullet treatment would ideally be a medication only hit the enemy or intervention that precisely targets the underlying cause or mechanism of the disease, providing significant

relief or a cure without causing adverse effects or impacting healthy tissues. NPs have the potential to be effective drug carriers when combined with targeting ligands and possess many of the properties of a miracle cure. The term "miracle cure" originates aimed only at killing parasites in the body and ultimately has minimal negative effects on the human body While they offer exciting possibilities, more research is needed to make sure they're safe, work well in different people, and can be produced reliably. If successful, these advancements could mean better treatments that improve the lives of those with conditions like asthma, COPD, and cystic fibrosis.

CONCLUSION

In conclusion, nanoparticle-based drug delivery systems represent a groundbreaking solution for addressing chronic pulmonary diseases. Acting as targeted carriers, these "magic bullets" precisely deliver medications to affected lung regions, enhancing drug efficacy while minimizing collateral damage to healthy tissues. Their adaptability allows for personalized treatment, encapsulating various therapeutic agents for tailored patient care.

Although promising, challenges like safety, scalability, and long-term effects necessitate further investigation and refinement. Despite these obstacles, the potential for improved treatment outcomes and reduced side effects signifies a transformative shift in managing chronic pulmonary diseases. Continued research and development in this area hold the key to unlocking the full therapeutic potential of nanoparticle-based drug delivery systems, potentially revolutionizing patient care in the future.

REFERENCE

1. Wang J, Wang P, Shao and Y He,D, Advancing Treatment Strategies: A Comprehensive Review of Drug Delivery Innovations for Chronic Inflammatory Respiratory Diseases, Pharmaceutics, 2023; 2151: 1-2.
2. Siqin He, Jiajia Gui, Kun Xiong, Meiwan Chen, Huile Gao and Yao., Journal of Nanobiotechnology, 2022; 20(10): 1-3.
3. David H, Elliott: Human respiratory system, Encyclopaedia Britannica, 2023; 1-2.
4. Patwa A, Shah A., Anatomy and physiology of respiratory system relevant to anesthesia, Indian J Anaesth, 2015; 59(9): 533-537.
5. Stan Ejiofor and Alice M. Turner Pharmacotherapies for COPD, 2013; 7: 1-6.
6. Paul W Jones, Henrik Watz, emiel FM Wouters, Mario Cazzola, COPD: the patient perspective International Journal of COPD, 2016; 13-14.

7. Jadwiga A Wedzicha, Terence A R Seemungal COPD exacerbation: defining their cause and prevention Lancet, 2007; 370: 786-788.
8. Marc Decramer, Christopher B Cooper, Treatment of COPD: the sooner the better Respiratory Division, University of Leuven, Belgium, 2010; 65: 837-838.
9. Jennifer E. Fergeson DO, Shiven S. Patel MD, Richard F. Lockey MD Acute asthma, prognosis, and treatment, 2017; 139(2): 838-840.
10. Jaclyn Quirt, Kyla J. Hildebrand, Jorge Mazza, Francisco Noya and Harold Kim, Allergy Asthma Clin Immunol, 2018; 14(2): 15-16.
11. Jennifer L. McCracken, MD, Sreenivas P. Veeranki, MBBS, Diagnosis and Management of Asthma in Adults JAMA, 2017; 318(3): 279-280.
12. Jayanta K. Patra, Gitishree Das, Leonardo F. Fraceto, Estefania Vangelie R. Campos, Maria del Pilar Rodriguez-Torres, Laura Susana Acosta-Torres, Luis Armando Diaz-Torres, Renato Grillo, Mallappa Kumara Swamy, Shivesh Sharma, Solomon Habtemariam and Han-Seung Shin Nano based drug delivery systems: recent developments and future prospects Patra et al. J Nanobiotechnology, 2018; 16: 1-2.
13. Sandeep Singh, Vivek K. Pandey, Ravi P. Tewari and Vishnu Agarwal: Nanoparticle based drug delivery system Indian Journal of Science and Technology, 2011; 4(3): 0974- 6846.
14. Nirmal Marasini, Shadabul Haque, Lisa M. Kaminskas Polymer-drug conjugates as inhalable drug delivery systems, 2017; 31: 18-19.
15. Zaheer Ahmada, Afzal Shah, Muhammad Siddiqa and Heinz-Bernhard Kraatz Polymeric micelles as drug delivery vehicles, 2014: 17028.
16. Mingjun Liu, Jean M.J. Fréchet Designing dendrimers for drug delivery, 1999; 2(10): 393-401.
17. Lisa Sercombe, Tejaswi Veerati, Fatemeh Moheimani, Sherry Y. Wu, Anil K. Sood, and Susan Hua Advances and Challenges of Liposome Assisted Drug Delivery. Frontiers in Pharmacology, 2015; 6: 1-2.
18. Young H. Chung, Hui Cai b, Nicole F. Steinmetz Viral nanoparticles for drug delivery, imaging, immunotherapy, and theranostic applications, 2020; 156: 214.
19. Shikha Singh Harshil Patel Manish Goyani Pinkisha Patel carbon nanotubes – a novel drug delivery system Multidisciplinary International Research Journal of Gujarat Technological University volume 3 issue 1 january, 2021; 97-98.

20. Kwangjae Cho,1 Xu Wang,1 Shuming Nie, 2 Zhuo (Georgia) Chen,1 and Dong M. Shin1 Therapeutic Nanoparticles for Drug Delivery in Cancer Clin Cancer Res, 2008; 14(5): 1310-1312.
21. Sadikot R.T The potential role of nanomedicine in lung diseases Medical Research Archives, 2018; 6 (5): 1-9.
22. Mohammad Doroudian, Ronan MacLoughlin, Fergus Poynton, Adriele Prina-Mello, Seamas C Donnelly Nanotechnology based therapeutics for lung disease, 2019; 74: 965–976.
23. Ashagrachew Tewabe, Atlaw Abate, Manaye Tamrie, Abyou Seyfu, Ebrahim Abdela Siraj Targeted Drug Delivery — From Magic Bullet to Nanomedicine: Principles, Challenges, and Future Perspectives Journal of Multidisciplinary Healthcare, 2021; 14: 1711–1713.
24. Akhand P. Singh, Arpan Biswas, Aparna Shukla and Pralay Maiti, Targeted therapy in chronic diseases using nanomaterial-based drug delivery vehicles, 2019; 4(33): 2-16.
25. Afzal Shah, Saima Aftab, Jan Nisar, Muhammad Naeem Ashiq, Faiza Jan Iftikhar Nanocarriers for targeted drug delivery, 2021; 62: 5-9.