International peer reviewed open access journal

Journal of Medical Pharmaceutical and Allied Sciences

Journal homepage: www.jmpas.com CODEN: JMPACO

Review article

Appraisal, recent advancement, and impacts of nanomedicine in cardiac asthma

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Received - 07-06-2023**, Revised** - 11-09-2023, **Accepted** - 17-10-2023 **(DD-MM-YYYY)**

Refer This Article

Jeetendra Kumar Gupta, Abdul Razak Mohamed Sikkander, Faizan ul Haque Nagrami, Krishan Kumar, Nitin Wahi, 2023. Appraisal, recent advancement, and impacts of nanomedicine in cardiac asthma. Journal of medical pharmaceutical and allied sciences, V 12 - I 5, Pages - 6132 – 6138. Doi: https://doi.org/10.55522/jmpas.V12I5.5214.

ABSTRACT

Cardiopulmonary asthma is a type of coughing, not an external appearance of asthma. Depending on persistent symptoms, this full-to-the-brim situation can be used to survive a therapeutic emergency. Liquid composition in the lungs and the area around the airways may result from heart failure. This demonstrates how the direction causes symptoms such as shortness of breath, coughing, and bursting at the seams which are likecipher and asthma symptoms. The common condition known as asthma is brought on by airway sensitivity, which can lead to constrictions, most noticeably leading to breathing difficulty. Heart failure treatment is trained to ease the effects of cardiac asthma and heart failure symptoms. Current developments in nano science and nanotechnology point towards a wealth of novel ideas for understanding and treating cardiovascular, pulmonary, and hematological conditions. Asthma is a common complaint that provokes the airways through various causes. Additionally, these instances consistently run into issues with their management schedule pertinent to the collection of the complaints. Asthma quantifiable treatment currently relies primarily on glucocorticoid medication therapy; however, the development of more effective treatments is hampered by glucocorticoid conflict as well as numerous elevated possessions due to deprived drug delivery. Our fundamental understanding of cardiac asthma nanomedicine therapy is updated in this review.

Keywords: Asthma nanomedicine, Nano-modification of drugs, Nanoparticle-like nanomaterials, Drug delivery, Nano-therapy.

INTRODUCTION

Nanotechnology is a developing subject of study that has been extensively explored in medical research [1]. Numerous studies suggest that exposure with the goal of medication delivery could greatly improve targeting, lower toxins and increase the bioavailability of medications [2]. The application of the manifold nanoparticle (NP) liberation strategy may revolutionize the counter active efficacy of medicine compared with the customary delivery style [3].Here, the authors obtain the mechanism of asthma expansion and contemporary counter active style[4] (Figure 1). Similarly, various types of nanomaterials and micro materials, including polymeric nanomaterials, concrete lipid nanomaterials, cell membrane-beached nanomaterials, and quintessence nanomaterials, have been designed and combined for use in asthma medications [5]. Finally, the difficulties and unexplored potential of these nanomaterials are discussed to provide leadership for tasks that go beyond research directives and fervently support the quantitative application of nano therapeutics for treating asthma [6] (Figure 2).

The World Health Organization claims that asthma is the

condition that is spreading the fastest over the world alongside HIV/AIDS and that its socioeconomic toll is greater than that of both HIV/AIDS and tuberculosis combined [7]. More severe communal and communal physical conditions enterprises are covered by their far above-ground disability and fatality rates [8]. Inheritable polymorphisms and environmental variables interact in diverse asthma complaints [9] (Figure 3).

Figure 1: Factors influencing Nanomedicine development and applications.

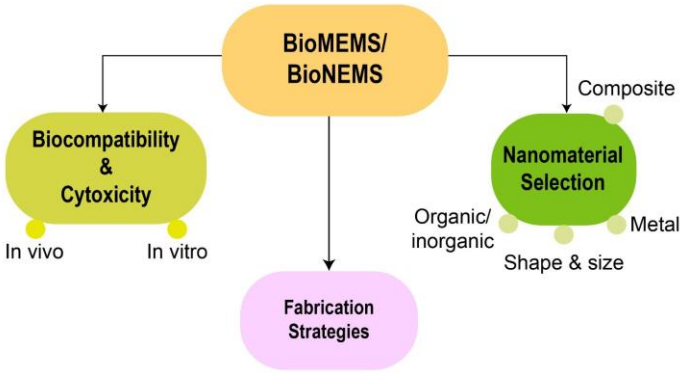
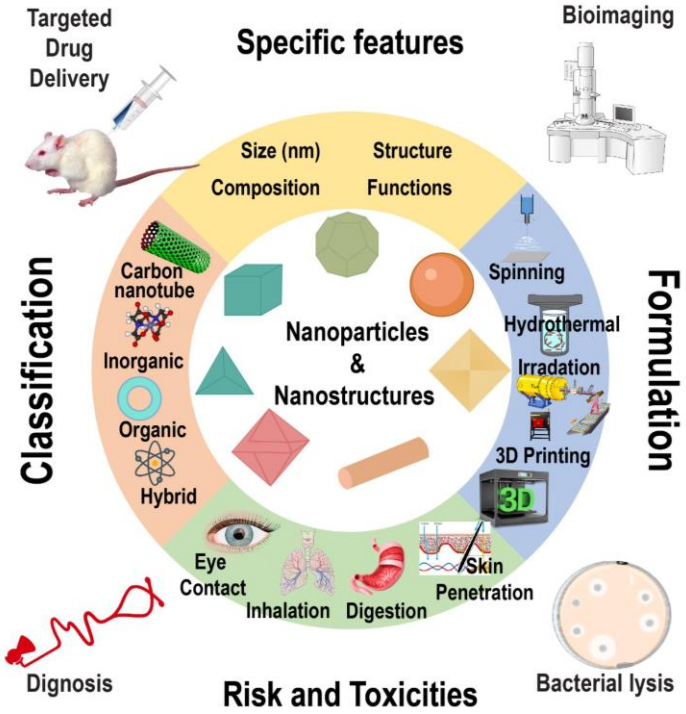


Figure 2: Key properties of nanomaterials employed for the treatment of Cardiac asthma.



Due to the diverse pathophysiology of asthma, exact treatment has not been possible; nevertheless, the advancements in nanotechnology have led to the development of novel temporary solutions for the diagnosis, treatment, and deposit of asthma [10]. Nanotechnology has the potential to modify medication bioavailability, reduce poisonous goods, and transport medicine or genes under attack [11]. The development of novel nano medicines and the evolution of nano medicines include a shift toward novel command structures [12]. The National Heart, Lung, and Blood Organization formed a working committee on nanotechnology in response to the difficulties and opportunities presented by this science that is still in its infancy [13] (Figure 4).

Figure 3: Genetic and environmental factors predisposition towards cardiac asthma.

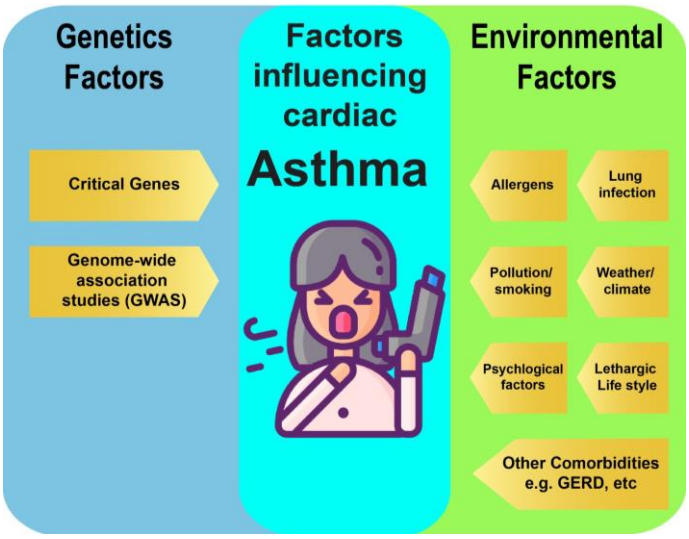
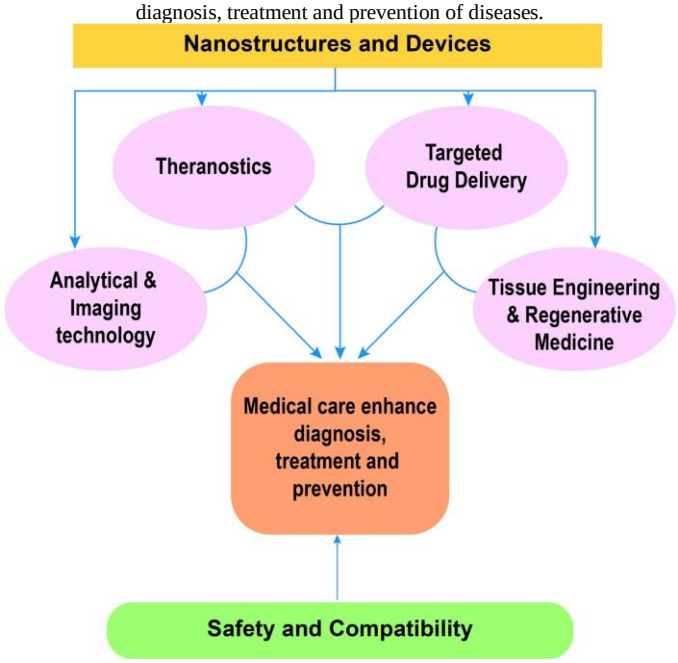


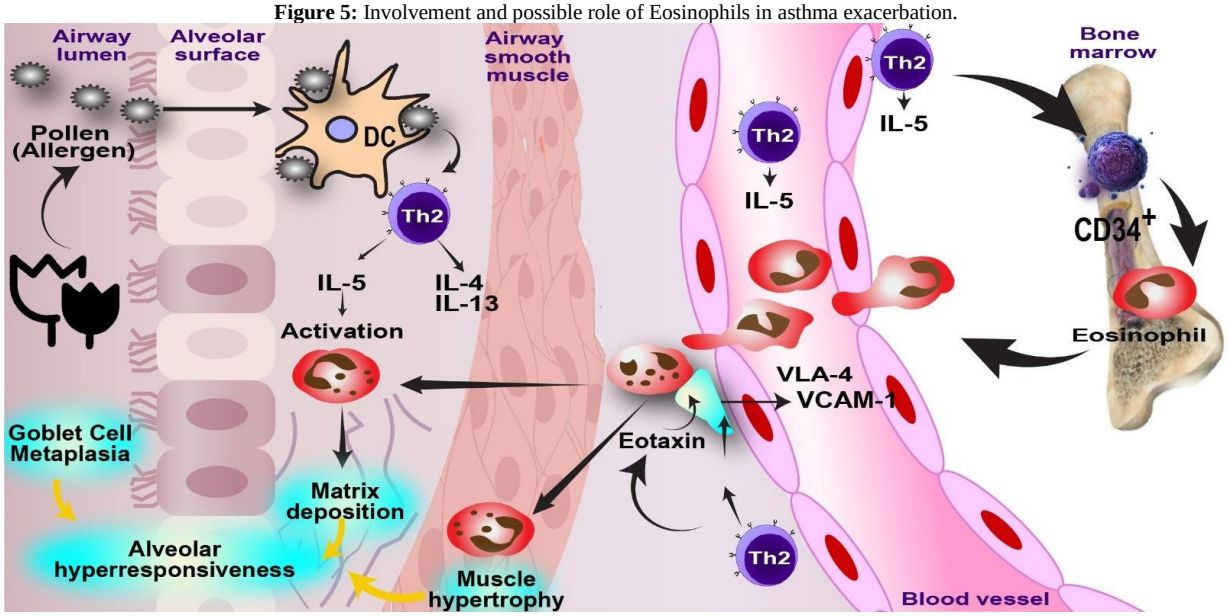
Figure 4: Novel Nano medicines approach could enhance medical care, diagnosis, treatment and prevention of diseases.



The multi colored nature of nanotechnology and how it operates in the heart, lung, blood, and sleep (HLBS) environment were discussed by operational grouping players [14]. This description outlines their discussion in terms of methodical openings, perceived needs and barriers, unambiguous complaint examples, and suggestions for reducing movement within the turf [15]. The operational group's overriding recommendation was to consider the translational application of nanotechnology to solve medical problems [16]. The construction of a multidisciplinary research Centre capable of increasing the operation of nanotechnology in addition to nano science for HLBS investigation and treatment is not required by the functional group [17]. Additionally, centers would provide specialist resources, reserves, and training for creative investigators. Researchers from these centers are expected to have a positive outlook when considering how nanotechnology might be used to solve common and medical issues [18].

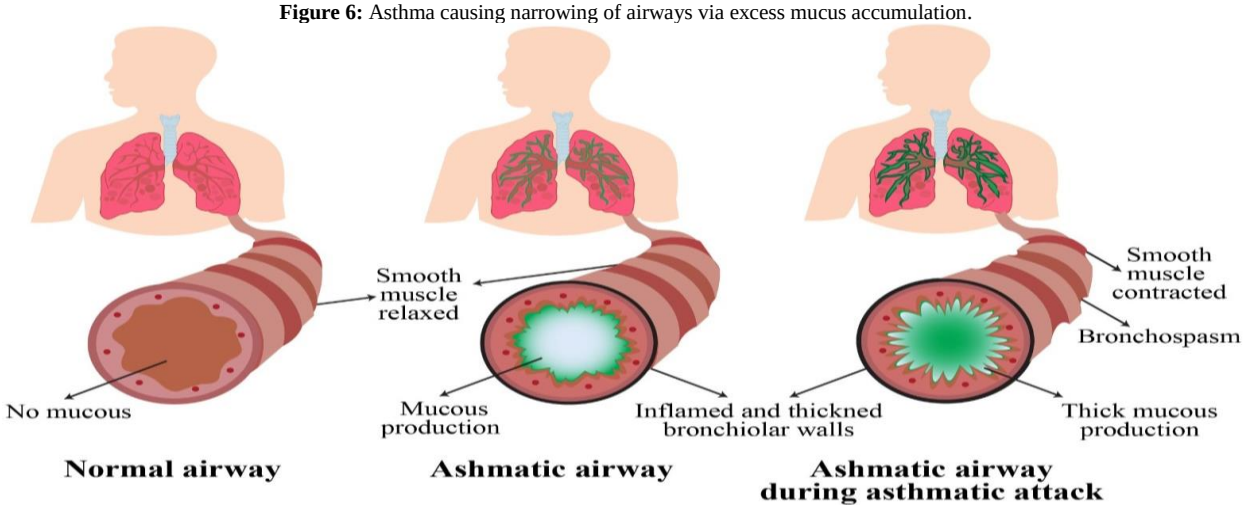
An untried examination needed in order to draw creative researchers towards the issue and arouse curiosity in creativity far beyond the classical studies [19]. Eventually, it will be required to encourage small enterprises to create experimental problem-solving strategies with a nanotechnology focus [20]. AHR, eosinophil penetration, mucus hyper secretion, reversible tailwind embarrassment, and food service cell propagation are prevalent airway subversive complaints linked to asthma [21]. The other quantitative instantiations are coughing, being out of breath, and dispelling. Numerous things, such as susceptible stimulants like allergen-specific immunoglobulin E (IgE), as well as non-immune stimulants brought on by exercise or certain features, can cause or worsen asthma [22] (Figure 5).

Figure 5: Involvement and possible role of Eosinophils in asthma exacerbation.



In addition, rotundity and heredity are significant causes of asthma [23]. Individuals with asthma worldwide are predicted approx. 400,000,000 by 2025. There are numerous instances where asthma is taboo [24]. The group that is currently paying attention is largely focused on the type of pain and susceptibility cells involved, which have the capacity to be separated into Th2-high and low subtypes [25]. In the progression of the high subtype, cytokines including interleukin IL-4, 5, and 13 produced by Th2 cells predominate, and their accumulation is mostly linked to bronchial pain, downy influence constriction, and excessive accumulation of mucus in the airway [26]. Furthermore, it adds to superfluous fibrosis, collagen scarring, and permanent airway remodeling , all of which exacerbate the complaints process [27]. The T coadjutor 17(Th17) signal pathway serves as the main intermediary in the Th2-low sub type of asthma, often known as cruel asthma [28]. When it comes to severe asthma, the Th17 cytokine state has been connected as a major contributing component and has been demonstrated to be significantly present in sufferers [29]. Regardless of the type of asthma, it's critical to swiftly reduce airway irritation and support the false start of the allergen sensing mechanism [30]. Medication therapy has a significant role in asthma management. With certainty, glucocorticoids are swallowed [31] (Figure 6).

Figure 6: Asthma causing narrowing of airways via excess mucus accumulation.



As a result of the precise distribution of glucocorticoids to glucocorticoid receptors, it can inhibit the excessive initiation of signal pathways like NFκB and MAPK, delay the expansion of subversive cells, and decrease the expression of provocative factors to treat

asthma. (Figure 7) [32]. Prolonged unrestricted glucocorticoiduse can result in numerous conditions, including diabetes, growth suppression in the womb, osteoporosis, and medicine resistance. Glucocorticoids have recently been utilized in conjunction with additional medications in the form of small boluses to provide additional support for adverse effects [33]. The combination of theophylline's ability to enhance histone deacetylase 2 (HDAC2) and restore steroid perception can reduce airway discomfort [34].

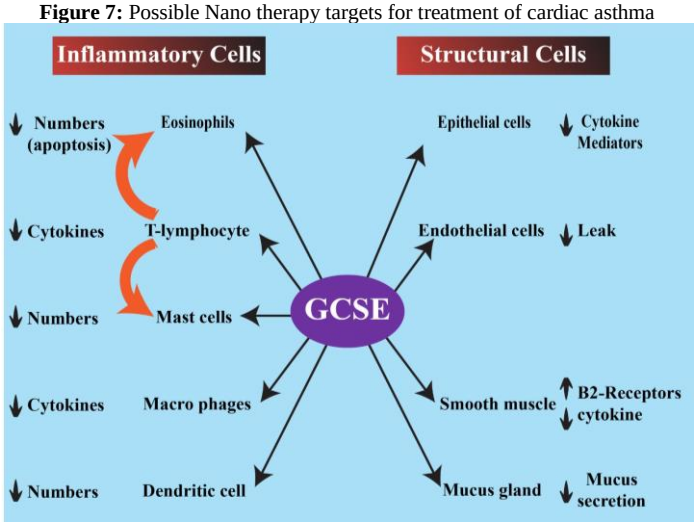
Theophylline has a lot of undesirable side effects, like making the dead experience nausea, headaches, and seizures [35]. Additionally, prolonged beta-agonists, which are also frequently used in asthma, lessen the inflammatory response by preventing the thymic stromal lymphopoietin gene from being expressed in the bronchi. [36].

More and more curatives for the treatment of asthma have been discovered thanks to the information and wisdom explosion that has occurred so quickly [37]. The medication of choice for treating teenage asthma behavior is long-acting 2-receptor agonists [38]. Leukotrienes have also been carefully considered as a novel target of asthma therapy in recent experiments since they are important lipid intercessors of hostile circumstances [39]. Leukotrienes cause inflammation during antagonistic responses in the airways, and their receptor antagonists can operate as a protective measure by preventing bronchoconstriction, bronchial inflammation, and elevated mucus production [40]. Curatives derived from monoclonal antibodies (mAb) are becoming more popular [41].

Numerous mAbs have been currently being used in animal studies, e.g., those against IgE (omalizumab), IL-33R (CNTO 7160), IL-4R (dupilumab), and IL-5 (mepolizumab and reslizumab). Antihistamines and medications that resemble masks are also key components in the management of asthma [42,43]. By interposing the histamine signal, unambiguous histamine receptor blockers reduce bronchial discomfort [44]. As an asthma emergency treatment, anti-allergic medications like loratadine or cetirizine are acceptable [45]. For instance, some antihistamines have the potential to cause adverse effects like drowsiness and cardiac arrhythmias and therefore are illegal to use in several nations [46]. Asthma's counteractive effects have been improved by the introduction of modern treatments, although the handling effect varies considerably owing to characteristic differences [47]. As a result, there is a clear need to expand effective asthma treatment [48]. Nanotechnology has recently undergone extensive development in modern drug and pharmacy operations [49]. In addition to enabling tailored medicine distribution, slowing down the liberation of medications, improving medication solubility; nanomaterials also offer egregious benefits for flawless pharmacokinetics, delayed blood rotation time, and reduced medication venom [50].

NPs distinctive properties, physic chemical nature, size, biocompatibility, excellent minimal cytotoxicity, nanomaterials have become a hotspot for experimenters across a variety of fields [51]. Numerous nano- and micro-materials, for the treatment of asthma, many nanomaterials, including polymeric nanoparticles, solid lipid nanoparticles, extracellular vesicle nanomaterials, and quintessence nanoparticles, have been studied [52]. The most popular and effective drug-release tools are polymeric nanoparticles, which have the highest degree of modifiability and a number of other advantages [53]. By acting as a buffer for protein and nucleic acid medications and preventing their rapid-fire decline in the body, nanoparticles not only improve the bioavailability of hormonal medications and lower the amount of hormones administered but they also significantly aid in the treatment of asthma [54]. Using nano- and micro materials to treat asthma is the topic of this analysis. We believe that doing so will bring up new ideas and inspire more brainstorming to support the broad use of nanotechnology in the treatment of asthma [55]. New nano medicines are typically safe and low-toxic therapeutic drugs or individual medications placed on innovative nano patch surfaces by using the most recent nanostructures or nano characteristics [56]. A fresh method for treating asthma has been successfully developed using the fusion of nano-genes and genes. This is due to the fact that various research has looked at innovative nano therapy for treating asthma and that the nonstandard terminology of multiple genes is usually always linked to the development of asthma [57].

Figure 7: Possible Nano therapy targets for treatment of cardiac asthma



In between, particular target molecules, such as specific ligands and monoclonal antibodies, are attached to the surface of nanoparticles. Nano-sized gene carriers sequester DNA and RNA in nanoparticles or adsorb them to the surface of nanoparticles, as the gene transfer vectors do [58]. Modern trends in gene therapy for asthma include picking and developing suitable nano carriers [59]. The nanoparticles can enter cells passing through cellular uptake by needing the target molecules with precise receptors on the face of cells, achieving safe and effective targeted medicine and gene curatives. A

promising treatment for asthma symptoms at the moment is cutting-edge nano-gene therapy. Finding a way to send DNA or RNA motes to the target cells has always been difficult in gene therapy [60]. Free DNA and RNA molecules will quickly get dishonoured because the mortal body contains a protective intermediate that is aligned with distant inheritable material and stops them from having the desired therapeutic effects. It is possible to bundle lipid molecules into nanoparticles that can house DNA and RNA molecules.

After being modified in terms of size and chemical makeup, these nanoparticles can be safely released into lung tissue. The difficulty of producing sustained, high-position gene expression in vivo is a major flaw of the nano carrier-based gene delivery technology. However, it does offer a very flexible platform for the delivery of therapeutic genes. There are many non-viral vectors based on liposomes and macromolecule polymers that can convert nucleic acids into nanoparticles for delivery to the lungs. For most people, poly ethyleneimine (PEI) is one of the most significant polymeric gene carriers. The effects of nanoparticles on the release of nucleic acids to the lungs have also been discussed, just like with chitosan dendrimers and environmentally friendly poly (lactic-co-glycolic) acid (PLGA).

RESULTSANDDISCUSSION

Nanotechnology has played a crucial role in the discussion of asthma management and has produced effective preventive products. Despite the highly regarded outcomes, attendance is stagnant until the attendance problem is resolved. Many nanoparticles are fragile when produced in large quantities for use in clinical operations because the drug advancement of some of them is complex, expensive, and has poor recurrence. Additionally, elements such assize, zeta potential, composition, and shape of the NPs have a significant effect on medication pulmonary distribution. Things that are persistent in the thickening mucus class of asthmatic belongings will be surpassed by NPs at some point. When combining, additional concentration requirements must be given attention to drug oozing that was replicated in NPs, corresponding to the burst discharge and seepage from NPs, which can impact the NPs stability. To treat asthma more effectively, the nanomaterial and endotracheal media interaction should also be considered. There are several repercussions of these difficulties. Nanoparticles could be made to have defense mechanisms against attacks, like the ability to perceive pain and tenderness. Drugs may be able to be loose under certain circumstances like acidic pH to release the drugs. In order to release them under attack in the lungs, pH-responsive nanoparticles with hydrophobic pH-sensitive passageways were constructed. Finally, it can be argued that nanoparticles are smaller, have targeted molecules, are electrically neutral, have high encapsulation efficacy, and have low toxicity to allow them to permeate the mucus layer and aid in improving the preservation duration in the lungs. Equipment with mucoadhesive packaging similar to CS can be used in the nanoparticles to prolong their retention in the lungs. The faces of the nanoparticles can be sculpted to order and made conspicuously. According to earlier studies, cut-modified nanoparticles can easily pass through the mucus barrier. The most important advancements in the treatment of asthma in recent years have been in the area of innovative therapies such as perfect medicine, endotypes, phenotypes, biomarkers, and biologics. Asthma biomarkers, phenotypes, endotypes, genotypes, and local patterns must be carefully examined in order to fully understand the diverse and complicated pathophysiology of the disease, which is why precision medicine is a good fit. Effective prophylactic measures and anti-attack medications ensure the beginning of the asthma treatment.

CONCLUSION

By taking asthma immunology into account, we can provide cases that substantiate and support healing target drug release in future investigations. Although nanotechnology is a confined option for the treatment of asthma, numerous preclinical studies have focused on this approach but no clinical experiments have been conducted. Clinical trials for COVID-19-related lung injury are currently on hold. There are still numerous obstacles to overcome in this procedure. To effectively treat asthma, it is imperative to create nanomaterials that can deliver drugs to the lungs and to continue researching the anti-asthma properties of nanomaterials. Even if significant progress has been made, more foresighted and straightforward exploratory approaches still need to be investigated to ease the difficulty of treating asthma and upto the point of clinical trials as quickly as feasible.

CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest

ACKNOWLEDGEMENT

I would like to acknowledge and give my warmest thanks to Dr.P. Manisankar, Former Vice Chancellor, Bharathidasan University, Trichy, and Tamil Nadu, INDIA who made this work possible. His guidance and advice carried me through all the stages of writing my paper. I would also like to thank coauthors for letting my defense be an enjoyable moment, and for your brilliant comments and suggestions. Finally, I would like to thank God, for letting me through all the difficulties. I have experienced your guidance day by day.

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