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EFFICIENCY OF NANOPARTICLES FOR DELIVERY OF DRUGS BY INHALATION

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ABSTRACT: The reason for this assessment became the blessing of the use of nanoparticles in lung disease. Nanotechnology has a critical characteristic in inhalation. The dosage shape of pulmonary drug shipping reaches to without delay into a scientific cycle to obtain the impact of the drug. The nanoparticles have a nanosize that achieves the preferred healthy without inflicting infection as compared to standard dosage forms. Various dosage kinds of the pulmonary drug shipping device meet the necessities of this assessment, like metered-dose inhalers, dry powder inhalers, and nebulizers. This drug has a significant impact on the target site. They are used for all kinds of diseases, including asthma, lung cancer, tuberculosis, and various lung diseases. You should easily get a nanometer particle length in the right place. Due to the physiological properties of the lung, the lung is suitable as a target organ for non-invasive short-range and systemic delivery of drug, primarily for non-bioavailable proteins and water-insoluble capsules for conventional drug delivery. Recently, inhaled nanoparticles have been shown to produce healing effects and reduce side effects while administered *via* the lungs. The possibility of delivering nanoparticles to the Department of Respiratory Medicine, especially given the latest discoveries in nanomaterials in environmental epidemiology and toxicology. Therefore, the purpose of this look is that the performance of nanoparticles is an excellent approach to lung drug delivery devices.

INTRODUCTION: Pulmonary drug delivery system: Since the lungs can absorb drugs for local deposition or systemic administration, they have become an attractive target for scientific and biomedical research. In forming the airway intima and regulation of airway tone, respiratory epithelial cells play a vital role.

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As a consequence of the lung's high permeability, large absorption area (around 70140 m^2 in adults with thin absorbing mucosa) and good blood supply, the lung route has been gaining increasing attention in the past few years as a non-invasive route to deliver systemic drugs and therapeutic agents to patients at home [1-2]. Most drugs and macromolecules are absorbed by the alveolar epithelium of the distal lung [3-5].

Mechanisms and Route of Pulmonary Drug Administration: Applied to the lungs, a wide range of therapeutic agents have been shown to be absorbed systemically in both animals and humans for more than a decade. In the lungs route, the drug

can be administered in two ways. One is intranasal administration, which has the following anatomical restrictions: Narrower airway lumen. Second oral inhalation administration: When administered orally, much better results can be expected since the concentration can be reduced by only 20% instead of 85% when administered nasally.

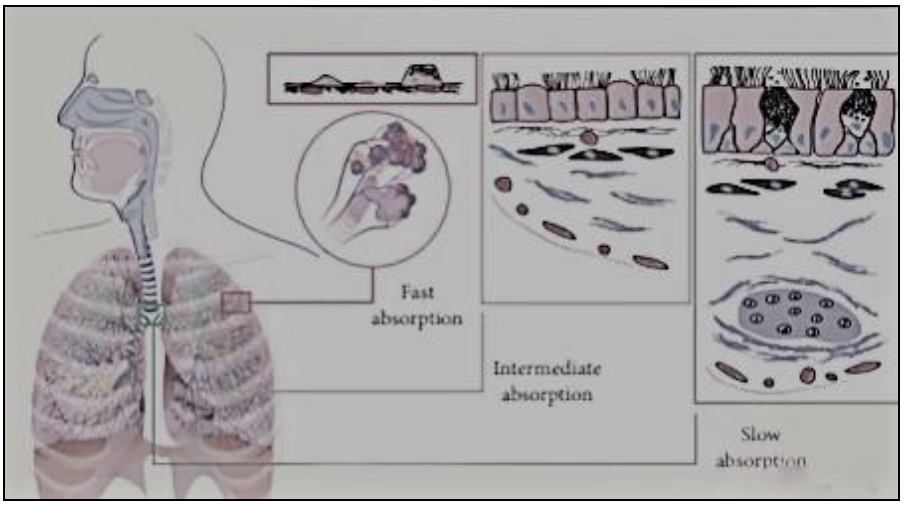

FIG. 1: SUMMARY OF PULMONARY ABSORPTION DYNAMICS BASED ON LOCAL PHYSIOLOGICAL CHARACTERISTICS OF THE AIRWAY REGION [6]

Inhalation: The breathing route is commonly used to treat asthma and chronic obstructive pulmonary disease. Compared to other administration methods, inhalation offers several advantages in treating these diseases. Inhalation, for example, imparts high levels of pulmonary drug concentration and low levels of systemic drug concentration since the drug is delivered directly to the target organ. The high pulmonary efficacy associated with drug inhalation typically leads to minimal systemic side effects. A pulmonary-specific pharmacokinetic process exists, and the lungs represent an organ with a complex structure, including

a) Drug particle/droplet deposition.

b) Pulmonary drug dissolution.

c) Mucociliary and macrophage clearance.

d) Absorption to lung tissue.

e) Pulmonary tissue retention and tissue metabolism.

f) Absorptive drug clearance to the systemic perfusion [7].

Inhaler Devices: These small wearable devices send jets of drugs into the airways. There are generally three types of inhalers.

Hydrofluoroalkane Inhaler (HFA) or Metered Inhaler or (MDI):
Dry Powder Inhaler (DPI):
Soft mist inhaler (SMI):
Nebulizers:

Hydrofluoroalkane Inhaler (HFA): The aerosol spray version of HFA is included. Drugs are stored in pressurized metering containers. Holding the inhaler 30 cm from your mouth, close your lips around the mouthpiece and slowly inhale while pressing down on it for a few seconds. Many people like to use spacers. An empty plastic tube attaches between the mouthpiece and the drug canister on the Hydrofluoroalkane Inhaler. To deliver the full dose of the drug to the lungs, spacers are used.

Dry Powder Inhaler (DPI): HFA emits liquid mist, while DPI emits dry powder dust. Do not use DPI with spacers. Instead, close your mouth tightly around the mouthpiece of the DPI inhaler and inhale quickly and evenly. To prevent the powder from becoming agglomerated, removing the device from the mouth before exhaling is important.

Soft Mist Inhaler (SMI): Inhalators like SMIs deliver a measured amount of medication as a mist that moves slowly to assist inhalation. The mouthpiece should be held horizontally while your lips are placed on the device. Ventilation vents

should be covered with great care. Drugs are actively administered through the device without being influenced by the rate in which the inhaler is breathed. There are many different inhalers, all of which work on the same principle. For example, you need to shake before using HFA, but not DPI. Each device has a different cleaning method and a different tracking method when empty. Be sure to follow the instructions for your specific device.

Nebulizer: Mist is generated by these machines and inhaled. It's difficult to keep a nebulizer at home since they are cumbersome. In order to use the machine, place the medicine in the cup and attach the hose to the machine. Then turn it on, relax and take a deep breath through the mouthpiece or mask to inhale the mist. Usually, it takes less than 20 minutes to inhale some drugs. Secondly, the nebulizer and mouthpiece or mask should be cleaned with soap and water before reusing [8].

Nanoparticles: The delivery of drugs using nanoparticles is targeted at a specific site. They target the organ being treated with specificity. Due to their very small particle sizes and more powerful nanos than other dosage forms, nanoparticles and nanodrug delivery systems are relatively new. In As of today, nanoparticles play critical roles in the treatment of many diseases as chemotherapeutics, biologicals, and immunotherapeutics. Compared to traditional medicine, nanomedicines has more localized effects, is less toxic, and delivers drugs more precisely. A section on trends and prospects in nanomedicines is also included. Nanoscience plays an important role in the delivery of drugs. In addition, nanomedicines are discussed from the standpoint of their use as synthetic/neutral drugs. The delivery of drugs using several materials has recently become a focus of research, mainly for cancer treatment. It is interesting to note that pharmaceutical science uses nanoparticles to reduce drugs' toxic effects and side effects, but until recently, it had no idea that the delivery system itself was potentially dangerous. Nanoparticles for drug delivery pose unique hazards that go beyond the traditional hazards posed by chemicals in classical delivery matrices. Inhalation toxicity can be used to investigate nanoparticle hazards based on knowledge of particle toxicity. In the pharmaceutical industry, nanoparticles are used to minimize drugs' toxicity and side effects. However, until recently, scientists were unaware that the delivery systems could also pose a risk. Chemicals used in a traditional delivery matrix pose more hazards than nanoparticles for drug delivery [9].

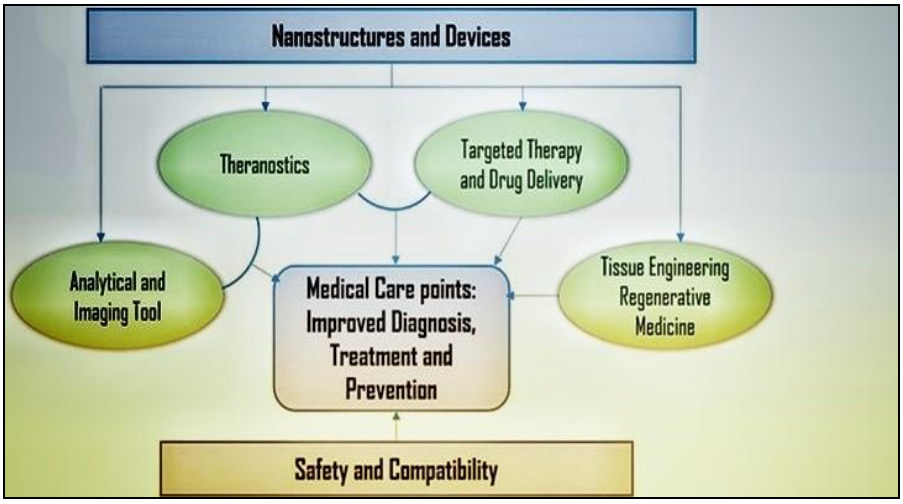

FIG. 2: VARIOUS APPLICATIONS AND GOALS OF NANOMEDICINE IN BIOMEDICAL RESEARCH [10]

An example of a nanoparticle is a solid particle of 10-1000 nanometers in size. An attached nanoparticle matrix dissolves, entraps, encapsulates, or encapsulates the drug. Depending on the preparation method, you can obtain nanoparticles, nanospheres, or nanocapsules. In nanocapsules, drugs are confined to a cavity surrounded by a polymer membrane, whereas in nanospheres, the drugs are physically and uniformly dispersed. As a result of their ability to circulate for extended periods as well as their ability to deliver proteins, peptides, and genes,

biodegradable polymeric nanoparticles, especially those coated with poly (ethylene glycol) (PEG) have recently been proposed as potential drug delivery devices, including as carriers of DNA in gene therapy, proteins, and peptides [11-14].

TABLE 1: APPLICATIONS OF NANOPARTICLES FOR VARIOUS DRUGS [15-29]

S. no.	Type of formulation	Name of drug	Result
1	Nanoparticles of bovine serum albumin	Rifampicin & Isoniazid	In double-loaded nanoparticles, INH release reached 97.02 percent after 6 days, and RIF release was complete after 5 days.
2	Nanoparticles of norbornene–polyethylene	Rifampicin & Ascorbic acid	A lower dosage of each medicine was needed with the NP dosing method. INH and RIF both had MIC values of 0.05 g / ml, while MIC values for H37Rv strains were 0.05 g / ml. nanoparticles it was 0.5 µg / ml. also
3	Alginate-tween 80 nanoparticles coated with CS	Rifampicin	According to the REMA technique, nanoparticles inhibited Mtb at concentrations between 0.039 and 0.31 g/ml, while the required free drug concentration ranged between 0.78 and 1.25 g/ml.
4	Magnetic iron oxide nanoparticles	Rifampicin	By cross-linking nanoparticle preparations with polyethylene glycol hybrid CS, gel beads were created, demonstrating the system's potential use as an anti-tuberculosis system.
5	HPMA-PLGA nanoparticles		The active ingredient releases about 90% of its strength within 4 hours. A quarter fewer nanoparticles were produced in hemolytic toxicity studies. However, the MIC value of the pure drug was one-fourth that of the MIC value for the diluted drug of 0.125 * 0.02 *g / ml
6	CS-coated PLGA nanoparticles		As compared to a non-nano particle dosage, nanoparticles enhanced intracellular transport and significantly increased drug concentration
7	Nano-lipomer		As a result of its first burst release, the developed lipomer showed rapid dissolution
8	Magnetic iron oxide nanoparticles		By crosslinking nanoparticle preparations with polyethylene glycol hybrid CS, gel beads were created, demonstrating the system's potential use as an antituberculosis system
9	PLGA nanoparticles	Tuftsin	The cell viability of the nanoparticles was > 90%
10	PLGA nanoparticles	Gatifloxacin	It was found that the drug was still present in the cerebral cortex 60 minutes after administering it. However, the levels in the lungs and liver were decreased, indicating that NP is effective in treating CNS tuberculosis.
11	Anti-oxidant linked amphiphilic polymeric nano-micelles	RIF and ferulic	*In-vitro* drug release confirmed that there was an increase in drug release from pH 5.3 to pH 7.4. Fluorescence studies of A549 cell lines Micelle
12	Nanocage	Zinc Oxide	The developed nanocage was demonstrated to have a high MIC of 12.5 mg / ml, demonstrating its potential for treating tuberculosis.
13	Nanocomposites	Rifampicin & Pryrazinamide	RIF and PZA had a sustained release of 79% and 82%, respectively, compared to the prepared formulations. Activity against acid-fast bacteria
14	Niosomes	Ethinamide & D-Cycloserine	BBD was used to optimize the formulation's bacteria-inhibitory properties, resulting in a superior formulation to free antibiotics.
15	Vesicles	Artemisone, clofazimine, and decoquinate	Zyl *et al.* proposed several formulations. MTB H37Rv lab distortion was maximally inhibited by 52% with niosomes

Role of Nanotechnology in Inhalation: Is it possible to control and inhale nanomaterials and remove them from the lung in the end. The physiology of the lungs makes them an ideal target for the delivery of both local and systemic non-invasive drugs, especially proteins and fluid. Low oral bioavailability of soluble drugs. Nanoparticles inhaled by the lungs appear to improve therapeutic efficacy and reduce side effects. Recent findings on the effects of nanomaterials in natural epidemiology and toxicology point to the potential of lung nanoparticle delivery [30].

Through the lungs, inhalation is the most common natural channel. Airways are responsible for transporting air in and out of the lungs, while

alveoli are responsible for air movement within the lungs (gas exchanges). Despite an active epithelium protected by mucus, particles have a difficult time passing through the airways. However, the barrier between the alveolar wall and the capillaries in gas exchange zones is thin and relatively weak [31]. Alveoli are less protected from environmental harm due to their large surface area and close contact with the blood. Lung cancer, for instance, maybe caused by certain respiratory disorders. The lung is a tumour cell's most likely destination in a cancer patient. Many standard medications and therapies are unable to alleviate the symptoms of these conditions. Researchers are pursuing many nanoparticle applications for respiratory applications to overcome the limitations of traditional medications. Treatment of lung diseases with nanoparticles is possible for asthma, TB, emphysema, cystic fibrosis, and cancer [32].

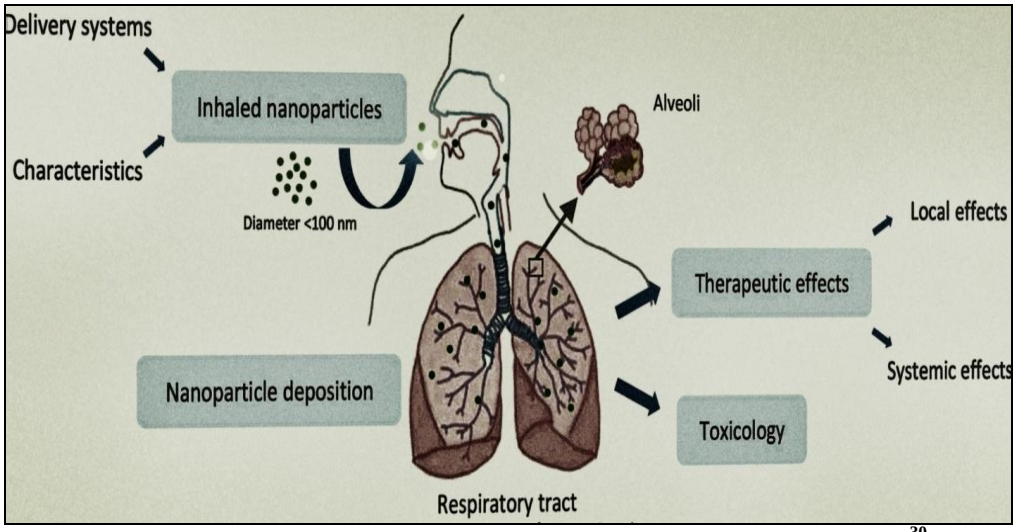

FIG. 3: PULMONARY SYSTEM FOR INHALED NANOPARTICLES [30]

Use of Nanoparticles in Various Diseases by Inhalation:

Asthma: Airway hyperresponsiveness is thought to contribute to asthma, a chronic inflammatory disease. Rhinitis and dyspnea were common symptoms among the patients. Airway remodelling can occur due to chronic asthmatic inflammation affecting the airways [33]. Current therapeutic strategies cannot reverse the damage, like breathing steroids. Asthma is usually treated with inhaled steroids; however, their pharmacological action is short-lived. Furthermore, users have been limited in utilizing these drugs due to adverse side effects, including adrenocortical suppression, Cushing's syndrome, and osteoporosis [34].

Tuberculosis: Tuberculosis, a chronic communicable disease caused by Mycobacterium tuberculosis, can be prevented by vaccine. Tuberculosis continues to kill millions of people worldwide every year, despite the availability of treatment for nearly half a century [35]. As a result of nebulizing ATDs containing nanoparticles, the drugs have improved bioavailability and reduced dosing frequencies, resulting in better pulmonary tuberculosis treatment [39].

Lung Cancer: Lung cancer is one of the most lethal tumors in both men and women [36] and chemotherapy is used as a supplement to surgery by Chemotherapeutic agents; however, it appears to produce side effects [37, 38]. Chemotherapy medications are delivered precisely to tumor cells using nanoparticle-based delivery technologies, thereby reducing toxicity [39].

CONCLUSION: Nanotechnology has been widely used in lung diseases since nano-sized particles can reach the targeted site without irritating the tissue or degrading the drugs. It has been recognized that the lungs are a natural transmission pathway for aerosols of macromolecules, which are normally susceptible to enzyme breakdown in the gastrointestinal tract and water-insoluble medicines. A recent study reports that nanoparticles can be produced and demonstrate satisfactory aerosol performance and therapeutic efficacy when inhaled. Numerous investigations have shown that

inhaled nanoparticles can improve local and systemic treatments, reducing systemic side effects caused by high doses. Nanotechnology and aerosol delivery of medication to the lungs offer amazing possibilities.

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