



**INTERNATIONAL JOURNAL OF
PHARMACEUTICAL SCIENCES**
[ISSN: 0975-4725; CODEN(USA): IJPS00]
Journal Homepage: <https://www.ijpsjournal.com>



Mini Review Article

Review On Nasal Drug Delivery System

Smita Borkar, Monika Bhosale*, Arati Lohar, Dr. V. Y. Lokhande

Department of pharmaceuticals, Arvind Gavali College of Pharmacy Jaitapur, Satara 415004, Maharashtra, India.

ARTICLE INFO

Published: 30 April. 2025

Keywords:

Nasal Drug Delivery Systems, Noninvasive Drug Administration, Anatomy and Physiology, Recent Advance mentbio availability; Congestion; Absorption Rate.

DOI:

10.5281/zenodo.15309915

ABSTRACT

Nasal drugs delivery has drawn a lot of interest as a practical, trustworthy, and encouraging approach to systemic drug delivery. It is specifically for compounds that are ineffectual when taken orally and only work when delivered intravenously. The nasal route offers benefits over other non-invasive medication delivery techniques. The current review discusses nasal delivery technologies while acknowledging their advantages and disadvantages. This review's objective is to present information on nasal medication delivery systems, including their benefits, drawbacks, drug absorption methods, nasal cavity anatomy, and variables influencing nasal drug administration. Methods for improving absorption through the nose, and methods for extending the half-life of nasal drug formulations.

INTRODUCTION

Because it's simple of manufacture and oral method of administration is the preferred and applied mode of medicine delivery. Research on alternative drug delivery methods began as a result of inadequate gastrointestinal absorption.^[1] The Ayurvedic system of Therapy is accepted in Indian medicine administered intravenously as a kind of treatment. More drug have recently demonstrated

that have larger oral nasal administration bioavailability when given orally.^[2] The nasal mucosa is perfect for systemic medication transport due to its high penetrability, high vascularity, and less enzymatic circumstances. Nasal delivery of protein and peptide molecules appeals to formulation scientists due to its non-intrusiveness and ease of administration.^[3]

Physiology And Nasal Anatomy

***Corresponding Author:** Monika Bhosale

Address: Department of pharmaceuticals, Arvind Gavali College of Pharmacy Jaitapur, Satara 415004, Maharashtra, India.

Email ✉: bhosalemonika22@gmail.com

Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.



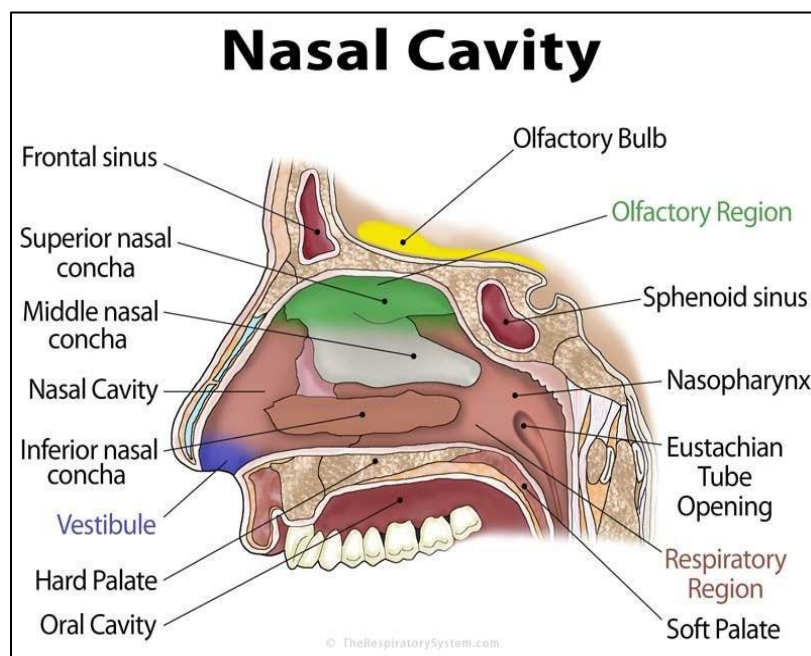


Fig. 1The Nasal Cavity's Anatomy

To evaluate medication absorption through the mucous membranes of the nose, it is crucial to comprehend the architecture and nasal physiology and its connection to the delivery system's operations method used.. The nasal channel that connects them to the nasopharynx via the nasal vestibule is around 12–14 cm deep. The mucus that shields the mucosa from the inspired air is in close contact with the nasal cellular machinery in this channel. ^[1] the nasal canals' vestibular, respiratory, and olfactory areas constitute three distinct functional zones.^[2] The human nasal cavity has a about total expanse 180cm² and a volume of roughly 16–19 ml. The septum divides it into two nasal chambers. The following are descriptions of a few of the regions.

- 1) The respiratory system
- 2) The respiratory system, the body's largest and densest circulatory system, is principally responsible for the absorption of medications through the gastrointestinal tract.
- 3) The system of vestibular^[2]

It is in charge of eliminating particles in the air and is located at the beginning of the nasal passages. It is thought to be the least important of the three zones in terms of drug absorption.

The Region of Olfactory

Because of its approximately 10 cm² surface area, it is crucial for the delivery of drugs to the brain and CSF. The olfactory epithelium is supported by the lamina propria, a thick connective tissue found in the human olfactory area. Blood arteries, axons, and the Bowens bundle are found in the lamina propria, whereas the epithelium is made up of three different cell types: olfactory receptor cells, supporting cells, and basal cells. Neurones are found between the supporting cells. A single dendrite that extends from the cell body to the free apical surface of olfactory receptor cells, also known as bipolar neurones, terminates in an olfactory knob that protrudes above the epithelium and is furnished with nonmotile cilia.^{2]}The mucus layer that protects the epithelium of the nose passages collects dust particles. Every 10 to 15

minutes, the cilia in the nasal cavity remove the mucosal secretions, which have a pH of 5.5 to 6.5 in adults. The nasal cavity contains a variety of enzymes, including glutathione S-transferase, carboxyl esterase, and cytochrome P-450.

Mechanism Of Nasal Absorption ^[4]

The first step of a medication's absorption occurs through the nasal cavity's mucus; large or charged particles may find this more difficult. However, tiny, unchanged particles can readily pass through this layer due to the nasal mucosa's absorption mechanisms. These include paracellular transport through cell-to-cell motion, vesicle-mediated transcytosis, transcellular, or straightforward membrane dispersion.^[4]

1. The first process includes the water transport system, often known as the paracellular pathway. Intranasal absorption is a slow and passive pathway with an inverse log-log relationship to the molecular weight of water-soluble substances. Decreased bioavailability was seen for medications having a molecular mass greater than 1000 Daltons.^[1]

2. The second mechanism transports medications that are lipophilic and have a rate dependence on their lipophilicity via a lipoidal pathway known as the transcellular process. Drugs can also pass through membranes actively, either by junction opening or carrier-mediated methods. To help in drug delivery, a natural biopolymer called chitosan can be used to open tight connections between epithelial cells.^[1, 4]

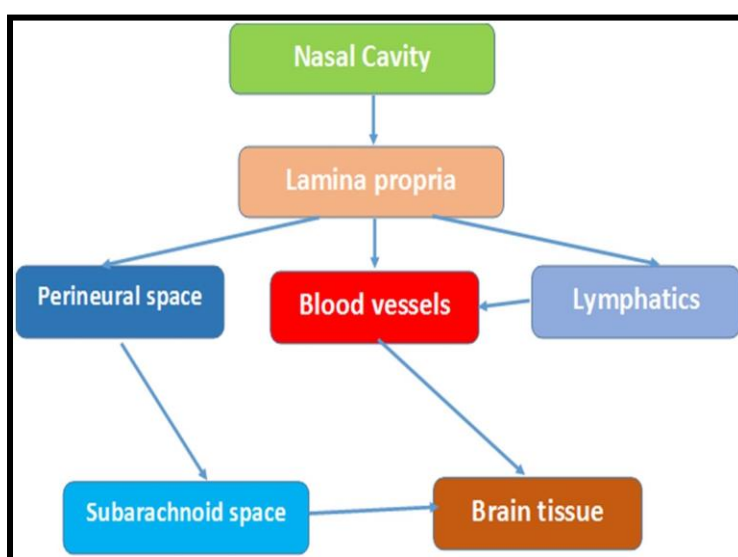


Fig No.2 Mechanism of Nasal Absorption

Advantage Of Nasal Drug Delivery System ^[5,6,7,8]

1. Directly enter the systemic blood circulation rather than passing through the liver and intestinal digestion first.
2. Drug degradation does not occur in the GIT tract.
3. The onset of action and the rate at which drugs are absorbed.

4. The bioavailability of drugs is better for smaller molecules.
5. It offers low molecular weight medicines, particularly lipophilic ones, good penetration.
6. Through the mucosa of the nose.
7. Lipophilic drugs can quickly cross the BBB.
8. Rapid medication absorption occurs through highly vascularized mucosa.

9. Ample nasal mucosal surface area is available for dosage absorption.
10. The action quickly begins.
11. non-intrusive and simple to administer.
12. Get around the BBB.
13. Drug degradation seen in the GIT is prevented.
14. There is no hepatic first pass metabolism.
15. Small medication molecules are well absorbed through the nasal cavity.
16. Absorption enhancers can boost the bioavailability of big pharmacological molecules.
17. Drugs that are inappropriate for oral administration can be successfully administered by nasal administration.
18. An alternative to parenteral delivery, especially for peptides and proteins.

Disadvantage Of Nasal Drug system of Delivery [9-11]

1. In comparison to the gastrointestinal tract, there is less surface area available for absorption in the nasal cavity.
2. Unlike oral delivery, discomfort is a possibility.
3. The drug and ingredients in the dosage form may cause long-term damage to the cilia of the nasal mucosa in addition to local side effects.
4. A dose form mechanical loss into the lungs or additional areas of the respiratory tract could occur as a result of inappropriate delivery methods.
5. Certain surfactants that are used as chemical boosters might harm or even dissolve the membrane when they are present in high enough concentrations.

Agents Impacting Nasal Drug Absorption

A) Drug-Associated Factors^[1, 6]

1. Chemical Weight: The physical and chemical properties of the substance have small outcome on

the penetration of drugs with molecular weights lower than 300 Dalton.

2. Chemical System: A medication's chemical formula is an essential factor in how well it is absorbed since it can change if it is transformed in the form of salt or ester.^[1]

3. Polymorphism: The effects of polymorphism on a drug's solubility, rate of dissolution, and capacity to cross biological membranes are well known. Research on the polymorphous steadiness and medicine purity for nasal precipitates and/or solutions is therefore essential.^[7]

4. Solubility and Rate of Dissolution: For better absorption, medications should dissolve. Particles make absorption a little more difficult.

5. Lipophilicity: The nasal mucosa becomes more permeable to the drug as lipophilicity increases. Because lipophilic chemicals can penetrate into the lipid (bilayer) of biological membranes and diffuse into and travel through the cell into the cytoplasm, Often, it is simple to penetrate Biological membranes go from one cell to another. In physical trials, medications such as testosterone have previously shown nasal absorption.

6. pKa and the partition coefficient: Since nonionized chemicals are better absorbed than ionized ones, according to the theory of pH partitioning, nasal absorption occurs similarly.^[1]

B) Formulation-Related Factors [8]

1. pH: The effectiveness of a medication's penetration can be affected by both the formulation's pH and the nasal surface's pH. To avoid nasal pain, the pH of the nasal formulation must be adjusted to 4.5–6.5.

2. Viscosity: Higher viscosity formulations prolong the duration of the medication's contact with the nasal mucosa, which prolongs the time it takes for penetration. Furthermore, formulations that are too viscous hinder the permeability of



medications by disrupting normal functions such as mucociliary clearance and ciliary beating.

3. Osmolarity: Maintaining optimal osmolarity is important because it decreases the size of the nasal epithelial mucosa and influences how drugs penetrate the nasal mucosa.

4. Nasal formulations typically have a buffer capacity of: provided in minuscule volumes ranging from 25 to 20 L. As a result, nasal secretions may alter the pH of the dosage. This may have an effect on the amount of union-produced medications that are available for absorption. It can be necessary to have a enough formulation buffer capacity in order to maintain the pH.

5. Drug dosage, dose volume, and drug absorption: These 3 interrelated factors move the effectiveness of nasal distribution. They are Concentration of Drugs, dose, and dose volume. It was shown that L-Tyrosine nasal absorption rose with medication concentration in nasal perfusion testing^[8]

C) Biology-Related factor

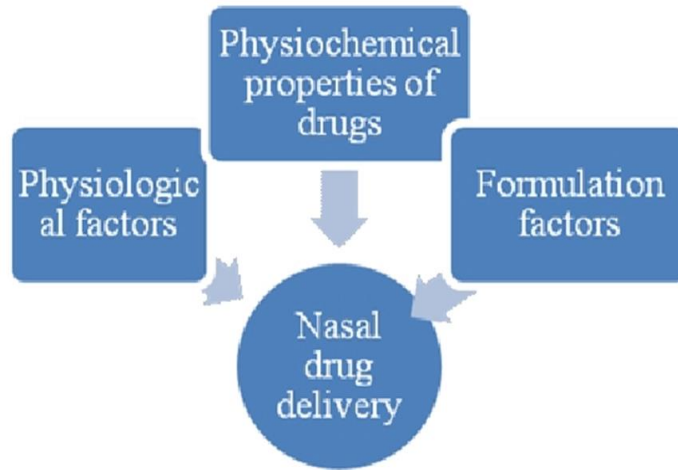
1. The impact of deposition following absorption: The nasal residency period is prolonged by placing the formulation in the front of the nose. While the posterior portion of the nose, where drug permeability is often higher, provides shorter habitation periods, the front portion of the nose has low permeability.

2. Nasal Blood Flow: The ability of a medicine to be absorbed will depend on how well the blood vessels dilate and contract since the nasal mucosal membrane has a high concentration of blood vessels and is crucial for regulating the air's temperature and humidity.^[4]

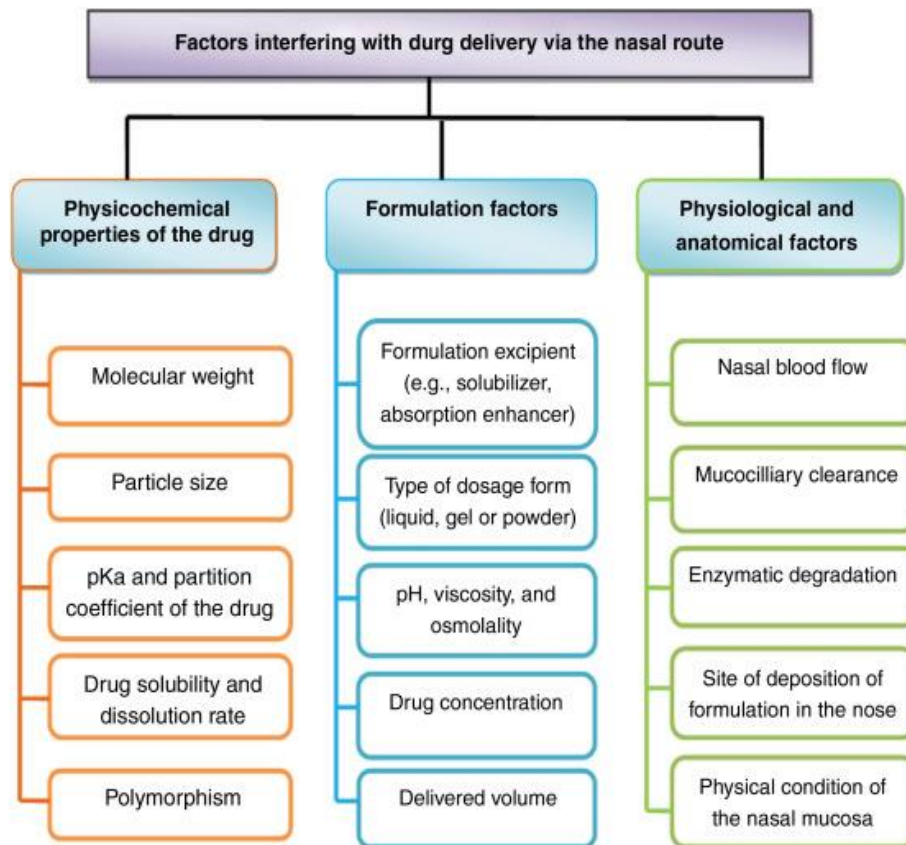
3. Effect of Enzymatic Activity: Numerous enzymes found in the nasal mucosa may have an impact on the stability of medications. For instance, proteins and peptides are broken down at the mucosal membrane by proteases and amino peptidases. Compared to the gastrointestinal tract, there is a significant decrease in the amount of amino peptidase present. Peptides and immunoglobulin (IGS) can mix in the nasal cavity to form complexes that have a higher molecular weight and lower permeability.

4. Mucociliary Clearance Effect: The total of time a medicine spends in residence (contact) with the epithelial tissue has an impact on how well it is absorbed. Mucociliary clearance, which is inversely connected with residence time, is inversely correlated with drug absorption.

5. Impact of Physical Health: Nasal mucociliary transport and/or nasal absorption ability may be impacted by intranasal diseases. The mucosa may occasionally be dry, bleed, or compress. There could be sinusitis, rhinorrhea, or a nasal infection. Excessive nasal discharge from severe nasal allergies may wash away the medication's formulation before it may begin to function locally or pass through the mucosa.



Figno.4: Factors Influencing the Nasal Drug Absorption



Drug Formulations for The Nose Are Evaluated [16, 17]

Studies on nasal permeation in culture. There are several methods used to calculate the formulation's drug diffusion across the nasal mucosa. To examine the drug diffusion profile, there are two distinct approaches.

(A) In vitro diffusion studies

The nasal diffusion cell was built out of glass. The recipient chamber holds 60 milliliters and is water-jacketed. The lid features three openings: one for a sample, one for a thermometer, and one for a donor tube chamber. The donor chamber has an interior diameter of 1.13 cm and measures 10 cm in length.

A donor tube chamber has a flanged top that is about 3 mm thick and a total capacity of 60 ml. After being removed from the sublayer bone tissues, the sheep's nasal mucosa was stoned in distilled water containing a few drops of gentamycin. Before the donor chamber tube is connected, all blood from the muscosal surface is extracted. The donor chamber tube is positioned so that it only touches the diffusion medium of the recipient chamber. 0.5 ml samples are taken from the recipient chamber and put into amber-colored ampoules at regular intervals. The extracted sample are suitably substituted. An appropriate analytical approach is used to estimate the drug content of the samples. 37 °C is the constant temperature at which the experiment is carried out.

(B) Studies on In Vivo Nasal Absorption

Animal models for research on nasal absorption There are two kinds of animal models used in nasal absorption research: entire animals, or in vivo models, and isolated organ perfusion, or ex vivo models. Below is a detailed discussion of these models: Rat model The operation For in vivo studies on nasal absorption, rats are prepared as follows: The rat is anesthetized by intraperitoneal injection of sodium pentobarbital. A polyethylene tube is used to cannulate the trachea following a neck incision. A second tube is inserted into the rear of the nasal cavity through the oesophagus. The nasopalatine tract is closed to stop the medicinal solution from draining from the nasal cavity through the mouth. The drug solution is administered to the nasal cavity by either the nostril or the cannulation tube. The femoral vein is where the blood samples are extracted. Due to the obstruction of all possible drainage channels, the medication can only be absorbed and administered into the systemic circulation.

Rat model

The following is how rats are surgically prepared for an in vivo nasal absorption study: Sodium pentobarbital is injected intraperitoneally to put the rat to sleep. A polyethylene tube is used to cannulate the trachea after a neck incision is done. An additional tube is sent through the oesophagus and into the nasal cavity's back. To prevent the medication solution from being emptied via the mouth from the nasal cavity, the nasopalatine tract channel is blocked. Either the nostril or the cannulation tubing is used to transfer the medication solution to the nasal cavity. Blood samples are taken from the femoral vein. Because all possible drainage outlets are blocked, the drug can only be absorbed and transported into the systemic circulation by penetration and/or diffusion through the nasal mucosa. A rabbit model The following are some advantages of using rabbits as an animal model for nasal absorption research:

1. Pharmacokinetic investigations with large animals (like monkeys) are made possible by it.
2. It is easily maintained in scientific environments, readily available, and reasonably priced.
3. The blood volume (about 300 ml) is sufficient.
4. to enable regular blood draws (1–2ml). It so makes it possible to fully characterize the absorption and determine the drug's pharmacokinetic profile. Depending on the goal of the study, rabbits (about 3 kg) are either kept conscious or put under anesthesia. In the anesthetized model, a ketamine and xylazine combination is injected intramuscularly into the anesthetized rabbit. The rabbit's head is held upright while a nasal spray of the drug solution is sprayed into each nostril. Throughout the experiment, the rabbit's body temperature is maintained at 37°C using a heating pad. Blood samples are taken from the marginal ear vein or artery using an indwelling catheter.



Rabbit model

When used as an animal model for research on nasal absorption, rabbits have a number of benefits.

1. It allows for pharmacokinetic research using large animals (such as monkeys).
2. It is reasonably affordable, widely accessible, and simple to maintain in scientific settings.
3. There is sufficient blood present (about 300 ml).
4. To enable routine blood sample (1–2 ml).

This makes it possible to fully characterize absorption and determine the drug's pharmacokinetic characteristics. Depending on the investigation's objectives, 3 kg of rabbits are either anesthetized or kept awake. In the anesthetized model, xylazine and ketamine are injected intramuscularly into a rabbit that is under anesthesia. The rabbit's head is held up as a medicine solution is sprayed into its nasal passages. A heating pad is used to keep the rabbit's body temperature at 37°C throughout the experiment. An indwelling catheter is inserted into a marginal ear vein or artery to collect blood samples.

Models of Ex Vivo Nasal Perfusion

- The surgical setup and the in vivo rat model are identical. To reduce the amount of medication solution lost during perfusion studies, a funnel is positioned between the nose and reservoir. A peristaltic pump is used to pump the medication solution through the rat's nasal cavity from a reservoir that is kept at 37°C.
- The perfusion fluid exits the nostrils and returns to the reservoir via the funnel. The reservoir's medication solution is constantly shaken. The concentration of the drug remaining in the perfusing solution can be used

to determine how much of the medication was absorbed.

- Ex vivo investigations on nasal perfusion can also be conducted using rabbits as the animal model. The rabbit is put to sleep by administering parenteral urethane-promazine. A polyethylene neonatal endotracheal tube is used to cannulate the trachea following a midline neck incision.
- The oesophagus has been tied and divided. Flexible Tygon tubing is put into the proximal end of the oesophagus, advanced to the back of the nasal cavity, and sutured at the proximal and distal ends, respectively. The nasopalatine tract, which connects the nasal cavity to the mouth, is taped shut to prevent the nasal cavity from leaking medicinal solution. A peristaltic pump is used to recycle the medication in an isotonic buffer solution.

Investigations of In-Vivo Bioavailability

- Male rabbits in good health are used in an in-vivo bioavailability investigation. Six rabbits from each of the three study groups fasted for an entire day. A conventional preparation was given to one group, a test formulation was given to another, and no test compounds were given to a control group.
- Throughout the trial and their fast, the subjects are provided with unlimited water. Following the drug's administration, blood samples were extracted from the rabbits' marginal ear vein and put in heparinized centrifuge tubes at intervals of 0.5, 1, 2, 3, 4, 5, 6, 7, and 8 hours.
- The plasma is extracted from the blood samples by centrifuging them at 3000 g for 15 minutes prior to analysis. They are then stored at -20°C in a refrigerator. Drug removal from plasma can be accomplished as previously said, and the HPLC system can then be examined.



➤ Pharmacokinetic evaluations The plasma concentration vs. time plot is used to calculate pharmacokinetic parameters. These numbers can be used to determine the time to reach peak concentration (Tmax), area under the curve (AUC), and peak plasma concentration (Cmax). The semilogarithmic plasma concentration vs. time plot is used to calculate the elimination rate constant (Kel). The formula $t_{1/2} = 0.693/Kel$ can be used to get the elimination half-life ($t_{1/2}$).

2.	Nasal Inserts	Chlorpromazine, Albuterol
3.	Microspheres	Beta-Amyloid Fibril, Starch Microspheres, Dextran Gentamicin, Insulin, Desmopressin
4.	Microparticles	Serum albumin, Thiolate Chitosan Microparticles
5.	Dry Powder	Zolmitriptan
6.	Nasal Gel	Oxytocin, Metoclopramide Hydrochloride

Table 1-Formulation and Active Agents Used for Nasal Drug Delivery

Sr.no.	Formulation	Active Agent
1.	In-situ Nasal Gel	Midazolam, Insulin, Triptans, Diltiazem

Marketed Preparation [26, 27]

Nasal drug products (proteins and peptides) for systemic drug delivery in the market:

Table 2. Nasal drug products for systemic drug delivery in the market

Drug Substance (Product name)	Indication	Dosage form	Status	Manufacturer
Salmon calcitonin (Karil 200 I.E.)	Osteoporosis	Solution (spray)	Marketed	Novartis Pharma
Desmopressin (Minirin Nasenspray)	Antidiuretic hormone	Solution (spray)	Marketed	Ferring Arzneimittel
Buserelin (Profact nasal)	Buserelin	Solution (spray)	Marketed	Aventis Pharma
Nafarelin (Synarela)	Endometriosis	Solution (spray)	Marketed	Pharmacia
Oxytocin (Syntocinon)	Lactation induction	Solution (spray)	Marketed	Novartis Pharma

Table 3: Nasal Drug Products (NonPeptide) For Systemic Drug Delivery in the Market

Drug Substance (Product name)	Indication	Dosage form	Status	Manufacturer
Zolmitriptan (Asco Top* Nasal)	Migraine	Solution(spray)	Marketed	Astra Zeneca
Sumatriptan Imigran* Nasal	Migraine	Solution(spray)	Marketed	Glaxo SmithKline
Dihydroergotamin (Migranal* Nasal Spray)	Migraine	Solution(spray)	Marketed	Novartis Pharma
Estradiol (Aerodiol*)	Hormone replacement	Solution(spray)	Marketed	Servier

The Nasal Dosage Forms Have Advanced

1. Nasal Drops: The nasal drop is among the most straightforward and useful nasal delivery devices ever developed. Nasal drops may not be suitable

for prescription drugs due to the lack of dose precision in this approach. Reports indicate that nasal drops are more effective than nasal spray at delivering human serum to the nostrils.^{18]}



2. Nasal Spray: Solutions or suspensions can be used to create nasal spray formulations. A nasal spray can administer a precise dosage because metered dose pumps and actuators are readily available. These are improved than powder sprays since the latter irritates the mucosa.

3. Nasal Powders: This dosage form may be made if solution and suspension dosage forms cannot be made, for instance, due to the drug's volatility. The benefits of the nasal powder dosage form include no preservative and improved formulation stability. However, the suitability of the powder formulation depends on the solubility, particle size, aerodynamic properties, and nasal irritancy of the active drug and/or excipients. This method also has the advantage of enabling local drug application.[18]

4. Nasal Gel: Due to its high viscosity, decreased post-nasal drip, decreased taste impact from swallowing less, decreased anterior formulation leakage, reduced irritation from the use of calming and emollient excipients, and targeted delivery to the mucosa for improved absorption, the nasal gel attracted increasing interest. The nasal gel showed growing interest due to reduction of post-nasal drip, high viscosity, reduction of taste impact due to reduced swallowing, reduction of anterior leakage of the formulation, reduction of irritation by using soothing/emollient excipients and target delivery to mucosa for better absorption.^[19]

5. Nasal Inserts: Nasal inserts are novel solid, bio adhesive dosage forms that provide prolonged systemic medication delivery via the nasal route. The fundamental idea behind the dosage form is to avoid the sensation of a foreign body by removing nasal fluid from the mucosa after delivery and forming a gel in the nasal cavity.^[18]

Brand New Intranasal Medication Delivery System For CNS^[20]

a) Microemulsion

The microemulsion system has the potential to deliver in thenasally. Microemulsions are often combined with a co-surfactant. The systems are currently of interest to pharmaceutical scientists because of their potential to integrate a range of pharmacological chemicals and act as drug delivery vehicles. Drug solubilization and bioavailability, thermodynamic stability, ease of manufacturing and scaling up, and spontaneously production are some of the advantages. A complete understanding of the microemulsion's structure, phase behavior, thermodynamic stability factors, factors affecting drug release from the formulation, ideal microemulsion excipient requirements, and the potential applications and limitations of the microemulsion system is required to prepare a pharmaceutically.

b) Nano-particles

- Nanoparticles are compact colloidal systems in which the medicinal substance is either conjugated or adsorbed onto the particle surface or confined inside the colloidal matrix. Nanoparticles, which are primarily composed of polymers, lipids, or a combination of both, can deliver regulated and prolonged medication release.
- Among the nanosystems used to create nano drug delivery systems for the treatment of CNS disorders are solid lipid nanoparticles (SLN), nanostructured lipid carriers (NLC), lipid drug conjugates (LDC), carbon nanotubes, nanofibers, nanorobots, polymeric nanoparticles, nanospheres, nanosuspension, nanoemulsions, nanogels, nanomicelles, nanoliposomes, and nanoemulsions. It's unclear exactly how nanoparticles break down barriers. The released nanoparticles, however, cross the blood-brain barrier and enter the brain via a number of endocytotic pathways.
- It has been noted that endocytosis enables the small size of polymeric nanoparticles made



from albumin or poly (butylcyanoacrylate) to enter the brain. Because the BBB is so tiny, these nanoparticles pass through it unharmed and release the drug directly into the brain environment, where endocytotic absorption eventually biodegrades it.

c) **Microsphere**

- One of the specialized technologies that is gaining popularity for creating nasal goods is microsphere technology, which improves absorption and bioavailability by establishing extended contact with the nasal mucosa. Because the microspheres absorb moisture, the nasal mucosa becomes dry while they are present. Because of the reversible cell shrinkage that results, the tight (intercellular) connections are temporarily physically separated, increasing medication absorption. Despite being water insoluble, the microspheres employed in nasal drug administration absorb water into their matrix, which causes the spheres to enlarge and gel.
- The following ingredients are utilized to manufacture microspheres: hyaluronic acid, albumin, dextran, and starch. Microspheres of dextran and starch were given frequently. The formulation of microspheres has enhanced the bioavailability of proteins and peptides in several animals. A few low molecular weight medications have also been effectively administered in microsphere form. Depending on the bioadhesive substance used in formulation, microspheres have been seen to remain in the nasal cavity for three to five hours. Because smaller particles will enter the lungs, the optimal microsphere particle size requirement for nasal distribution should be between 10 and 50 μm .

d) **Nasal In-situ Gels**

In-situ gel formulations are drug delivery systems that are in solution form prior to administration to the body but undergo gelation to form gel after administration. This can be accomplished using a variety of polymers, such as carbopol, polxamers, PVA, and chitosan.

Applications

- Delivery of medicine instead of peptides Even without a permeation enhancer, small, non-peptide, low molecular weight drugs are effectively absorbed through the nasal mucosa.
- Nasal cavity pharmaceutical administration is useful for treating illnesses including pain, Parkinson's disease, and Alzheimer's disease because it allows for quick and/or precise drug delivery to the brain. The percentage of drugs that enter the central nervous system through nasal delivery will rise when nasal delivery devices for the brain are developed.

Vaccine Delivery via Nasal Route: The nasal mucosa is the first site of contact with inhaled pathogens; both mucosal and systemic immune responses are generated; nasal passages are abundant in lymphoid tissue; and nasal vaccine delivery is safe, non-injectable, affordable, and patient-friendly. In addition to a systemic immune response, nasal vaccination has been shown to produce a local immunological reaction in the nasal lining, providing an extra layer of defense. (Mestecky J et al., 1997). The vaccine induces the formation of local secretory IgG and IgA antibodies by injecting it directly into the nasal cavity, adding an additional line of defense that helps eradicate the illness before it has a chance to take hold.

Nasal decongestant:

With low therapeutic dosages and few systemic negative effects, the nose is used to address



localized issues. Low molecular weight medications that are hydrophobic or water soluble are utilized to address regional pathogenic conditions in the nose. Colds are also treated by using nasal decongestants, including xylometazoline.

Systemic Effects: Nasal administration is appropriate for acids-labile medications, peptides, and proteins⁶² when a prompt reaction is needed, such as in the treatment of migraines. Peptide and protein medications have a lower bioavailability (1–2%) due to their increased molecular weight and polarity, which makes it difficult for them to pass through the nasal mucosal membrane. However, the absorption of progesterone and propranolol through the nasal epithelium is similar to that of parenteral delivery⁶³. By adding permeation enhancers to the formulation and using bioadhesive agents to prolong the drug's contact time with the mucosal membranes, less bioavailability can be improved. When 0.1 percent N-succinyl chitosan was used as a permeation enhancer in rats, the relative bioavailability of isosorbide dinitrate increased significantly (to 69.85 percent) compared to the control groups (43.32 percent) and the 0.5 percent ...

Marketed Nasal Formulation

1. Nasal Drop



Fig. 1 Ephedrine Nasal Drops 0.5% w/v

2. Nasal Spray



Fig. 2 Vicks Vapospray

3. Nasal Gel



Fig. 3 Nasal Antisnoring Inserts [16]

CONCLUSION: -

There is new hope for the local and systemic distribution of medications due to the passage of drug molecules over the nasal mucosa. Another method of delivering drugs that work on the central, systemic, and local nervous systems is nasal drug delivery. Its benefits include reducing systemic exposure, which lessens adverse effects, and preventing first-pass metabolism. However, to create a workable nasal drug, several obstacles to the intranasal route need to be removed. Nasal absorption is largely affected by physiological circumstances, the physicochemical characteristics of the drug, and formulation. Future research will be crucial to increasing the effectiveness and attractiveness of this distribution strategy.

REFERENCES

1. Patel Chirag, Prof.SatyanandTyagi, DhruvMangukia, SojitraIshita, Patel Shreya, Patel Pinkesh, Umesh Kumar. A Recent Review on Alternative System of Parenteral Delivery: Nasal Drug Delivery System. *Journal of Drug Discovery and Therapeutics*, 2013; 1(1): 12-18.
2. J S. Paun, A. A. Bagada, M. K. Raval. Nasal Drug Delivery- As an Effective Tool for Brain Targeting- A Review. *International Journal of Pharmaceutical and Applied Sciences*, 2010; 1(2): 43-52 ISSN 0976-6936.
3. Bajpai Vibha. In Situ Gel Nasal Drug Delivery System- A Review. *International Journal of Pharma Sciences*, 2014; 4(3): 577-580 ISSN 2320-6810.
4. Kiran R. Jadhav, Manoj N. Gambhire, Ishaque M. Shaikh, Vilasrao J. Kadam, Sambhaji S. Pisal. Nasal Drug Delivery System- Factors Affecting and Applications. *Current Drug Therapy*, 2007; 2: 27-38.
5. Singh kumarArun.Nasal cavity: A promising transmucosal platform for drug delivery and research approach from nasal to brain targeting. *Journal of Drug Delivery and Therapeutics*. 2012;23:22- 33.
6. Chajed S., Sangle S., and Barhate S. Advantagious nasal drug delivery system; A review. *International journal of pharmaceutical science and research*. 2011; 2(6):1322-1336.
7. Zaheer A., Sachin.,Swamy. Mucoadhesive Polymers: Drug Carriersfor Improved Nasal Drug Delivery. *Indian Journal of Novel Drug Delivery*. Jan-Mar, 2012; 4(1): 2-16.
8. PagarswatiAppasahebShikharManoharSaudagarRavindrabhandra 2013 A review of intranasal drug delivery system *journal of advanced pharmacy education and research volume 3 issue 4*
9. Ilum L. Nasal delivery. The use of animal models to predict performance in man. *J Drug Target* 1996;3:427-42.
10. Dey S, Mahanti B, Mazumder B, Malgope A, Dasgupta S. Nasal drug delivery: An approach of drug delivery through nasal route. *Pelagia Res Lib* 2011;2:94-106.
11. Molinari G, Colombo G, Celenza C. Respiratory allergies: A general overview of remedies, delivery systems, and the need to progress. *ISRN Allergy* 2014;2014:326980.
12. Meghana S. Kamble, Kishor K. Bhalerao, Ashok V. Bhosale, Pravin D. Chaudhari. A Review on Nose-to-Brain Drug Delivery. *International Journal of Pharmaceutical and Chemical Sciences*, 2013; 2(1): 516-894 ISSN 2277-5005.
13. M. Parvathi. Intranasal Drug Delivery to Brain: An Overview. *International Journal of Research in Pharmacy and Chemistry*, 2012; 2(3): 889- ISSN 2231-2781.
14. J. S. Paun, A. A. Bagada, M. K. Raval. Nasal Drug Delivery- As an Effective Tool for Brain Targeting- A Review. *International Journal of Pharmaceutical and Applied Sciences*, 2010; 1(2): 43-52 ISSN 0976-6936.



15. Sanjay Dey, Beduin Mahanti, Bhaskar Mazumder, Anaya Malgope, Sandeepan Dasgupta. Nasal Drug Delivery: An approach of Drug Delivery through nasal route. Pelagia Research Library, 2011; 2(3): 94-106 ISSN 0976-8688.
16. Meghana S. Kamble, Kishor K. Bhalerao, Ashok V. Bhosale, Pravin D. Chaudhari. A Review on Nose-to-Brain Drug Delivery. *International Journal of Pharmaceutical and Chemical Sciences*, 2013; 2(1): 516-894 ISSN 2277-5005.
17. Machida M. Effects of surfactants and protease inhibitors on nasal absorption of recombinanthuman granulocyte colony stimulating factor (rHGCSF) in rats. *Biol. Pharm. Bull.* 1994; 17:1375–1378
18. Watanabe H., and Tsuru H. *Nippon Yakurigaku Zasshi* 1999; 113: 211–218.
19. Cornaz A.L., and Buri P. Nasal mucosa as an absorption barrier. *Eur. J. Pharm. Biopharm.* 1994;40: 261–270.
20. M. Menaka, v. P. Pandey, a. Anton smith formulation development and evaluation of ondansetron hydrochloride nasal spray (2013).
21. Sanjay Dey, Beduin Mahanti, Bhaskar Mazumder, Anaya Malgope, Sandeepan Dasgupta.
22. Nasal Drug Delivery: An approach of Drug Delivery through nasal route. Pelagia Research Library, 2011; 2(3): 94- 106 ISSN 0976-8688.
23. Costantino H.R., Lisbeth I., Brandt G., Johnson P.H., Quay S.C. Intranasal delivery: Physicochemical and therapeutic aspects. *International Journal of Pharmaceutics.* 2007; 337:1-2
24. Illum L. Nasal drug delivery-possibilities, problems and solutions. *J Control Release.* 2003; 87: 187–198
25. Özer AY. The importance of intranasal route for application of drugs and nasal drug delivery systems. *Pharm JTPA* 1990;30:136-47.
26. Hammarlund-Udenaes M, de Lange E, Thorne RG. Pharmacokinetic concepts in brain drug delivery in drug delivery to the brain. In: *Physiological Concepts, Methodologies and Approaches.* New York: Springer; 2014. p. 127-61.
27. Charlton ST, Davis SS, Illum L. Evaluation of bioadhesive polymers as delivery systems for nose to brain delivery: In vitro characterisation studies. *J Control Release* 2007;118:225-34.
28. Giuliani A, Balducci AG, Zironi E, Colombo G, Bortolotti F, Lorenzini L, et al. In vivo nose-to-brain delivery of the hydrophilic antiviral ribavirin by microparticle agglomerates. *Drug Deliv* 2018;25:376-87.
- [22] Mustafa E, Shaimaa NM, Al A. Design of zolmitriptan liquid-filled orodispersible tablets and their in vitro evaluation. *Int J Pharm Pharm Sci* 2016;9:297-303.
29. Zhang H, Lin CW, Donovan MD. Correlation between nasal membrane permeability and nasal absorption rate. *AAPS PharmSciTech* 2013;14:60-3.
30. Pelgrim GJ, Das M, Haberland U, Slump C, Handayani A, van Tuij S, et al. Development of an ex vivo, beating heart model for CT myocardial perfusion. *Biomed Res Int* 2015;2015:8.
31. Meghana S. Kamble, Kishor K. Bhalerao, Ashok V. Bhosale, Pravin D. Chaudhari. A Review on Nose-to-Brain Drug Delivery. *International Journal of Pharmaceutical and Chemical Sciences*, 2013; 2(1): 516-894 ISSN 2277-5005. [26] M. Parvathi. Intranasal Drug Delivery to Brain: An Overview. *International Journal of Research in Pharmacy and Chemistry*, 2012; 2(3): 889- ISSN 2231-2781.



HOW TO CITE: Smita Borkar, Monika Bhosale*, Arati Lohar, Dr. V. Y. Lokhande, Review on Nasal Drug Delivery System, *Int. J. of Pharm. Sci.*, 2025, Vol 3, Issue 4, 3424-3438
<https://doi.org/10.5281/zenodo.15309915>

