IASR J. Med. Pharm. Sci.
ISSN: 2582-9343
Website: https://ijmps.com/
Open Access Journal
Country: India

IASR Journal of
Medical and Pharmaceutical
Science

ORIGINAL ARTICLE OPEN ACCESS

A Review On Transdermal Drug Delivery System

Ashutosh Kumar Singh* [1], Ashutosh Kushwaha[2], Dr. Jai Narayan Mishra[3]

[1]Research Scholar, Kailash Institute of Pharmacy and Management, GIDA, Gorakhpur Affiliated to Dr. APJ Abdul Kalam Technical University, Lucknow, UP, India
[2]Associate Professor, Kailash Institute of Pharmacy and Management, GIDA, Gorakhpur Affiliated to Dr. APJ Abdul Kalam Technical University, Lucknow, UP, India
[3]Professor, Kailash Institute of Pharmacy and Management, GIDA, Gorakhpur Affiliated to Dr. APJ Abdul Kalam Technical University, Lucknow, UP, India

OPEN ACCESS

Corresponding Author
Nityanand Tiwari
Affiliation here

Received: 02-05-2025
Accepted: 24-05-2025
Available online: 23-06-2025

ABSTRACT

A transdermal drug delivery system (TDDS) falls under the controlled drug delivery order, aiming to administer medicines through the skin at a destined and controlled rate. This approach presents multitudinous benefits, similar as extended remedial impact, reduced adverse effect, increased bioavailability, enhanced patient adherence, and accessible termination of drug. The remotest subcaste of the skin, the stratum corneum, plays a crucial part in controlling the transdermal penetration of utmost substances. Three main routes grease medicine penetration appendageal, transcellular, and intercellular. When administering medicines through this pathway, it is essential to consider different factors, including the age and condition of the skin, physicochemical parcels, and environmental influences. pivotal rudiments of Transdermal Drug Delivery Systems (TDDS) include a polymer matrix, membrane, drug, penetration enhancers, pressure-sensitive bonds, backing laminates, and a release liner. Transdermal patches fall into orders similar as force systems, matrix systems, and micro- force systems, all specifically finagled to introduce active constituents into the circulatory system via the skin. A standardized approach is employed to estimate colorful aspects, including adhesion parcels, in vitro drug release and stability. The purpose of reviewing the content of transdermal medicine delivery system through patches is to exhaustively estimate the advancements, challenges, and implicit operations of this innovative drug delivery system.

Key Words: *Migraine, Bioavailability, Transdermal Patch.*

INTRODUCTION

Transdermal drug delivery systems (TDDS) relate to phrasings created to administer an applicable medicinal lozenge through a case's skin, icing the delivery of a remedial cure of the medicine into the body. In order to achieve systemic goods by transmitting remedial substances through mortal skin, it's essential to consider the skin's biophysical, morphological, and physicochemical parcels exhaustively. Transdermal medicine delivery presents notable advantages compared to injectables and oral routes, as it improves patient compliance and circumvents the first- pass metabolism[1]. It ensures a controlled and harmonious medicine administration, particularly salutary for medicines with short natural half-lives, precluding abrupt entry into the systemic rotation that frequently leads to adverse goods. As a result, colourful innovative medicine delivery systems, similar as Transdermal medicine delivery systems, Transmucosal delivery systems, and Controlled release systems, have been developed. The benefits of transdermal medicine delivery include bettered remedial effectiveness, reduced hepatic first- pass metabolism, and the conservation of a stable medicine attention in the bloodstream. The first transdermal system was FDA- approved in 1979 for precluding nausea and vomiting. evidence of percutaneous medicine immersion can be established through measurable blood situations, descry

excretion of the medicine and its metabolites in urine, observing the case's clinical response to the administered medicine therapy[2]. A transdermal patch is a technical treated patch designed to release medicines into the bloodstream at a controlled rate through the layers of the skin. These patches offer a largely accessible system of medicine administration, as they're effortless and can give nonstop treatment for several days. also, they can be fluently discontinued at any time. Transdermal patches come in colourful sizes and can contain multiple active constituents. When applied to the skin, these patches use prolixity processes to deliver these active constituents directly into the systemic rotation. Some patches may contain high boluses of the active element, which remains on the skin for an extended period. Nitroglycerin was the first transdermal patch developed in 1985, marking a significant corner in this medicine delivery system. Gale and Berggren developed patches that incorporate a ratecontrolling ethylene vinyl acetate membrane. colorful medicines are formulated as transdermal patches, similar as nicotine, estradiol, fentanyl, clonidine, scopolamine (hyoscine), and estradiol with norethisterone acetate. The specific point of patch operation depends on the type of medicine therapy[3.] For case, estradiol patches are generally placed around the buttocks or tummy, while nitroglycerin patches can be applied around the casket area. The duration of medicine release varies, ranging from as short as 9 hours to as long as 9 days, depending on the intended operation.

ADVANTAGES

Some advantages of transdermal patch

- Patches are simple to apply, effortless, andnon-invasive[4].
- The drug can be administered over a long length of time.
- Because a single patch distributes the drug continuously for a longer period, lozenge frequence is reduced.
- The medicine in the transdermal medicine delivery system bypasses first- pass metabolism by entering directly into the systemic rotation, making it suitable for medicinals that are reused by the liver, gut, or stomach pH.
- There's no medicine- food, enzyme- drink, or other Gastrointestinal tract foliage commerce.
- Applicable for senior individualities who are unfit to swallow capsules[5].
- Effective for specifics that lessen negative goods and are unwelcome when taken orally.
- medicine delivery can be stopped in the case of toxin by removing the patch.
- Patches can be tone- administered.

DISADVANTAGES

Some disadvantages of transdermal patch

- It's delicate to deliver ionic medicines through a transdermal medicine delivery system.[6]
- Difficulty in administering large boluses (further than 10 mg/ day).
- medicines with a molecular weight lesser than 500 Dalton are n't suitable for the transdermal medicine delivery system.
- High attention of medicines may beget skin vexation[7].
- High tube medicine attention are challenging to produce.
- Cases experience discomfort as a result of long- term adherence.
- It's challenging for specifics with exceptionally low or high partition portions to enter the systemic rotation[8].

ANATOMY AND PHYSIOLOGY OF SKIN

Indeed, the skin is the body's largest organ, acting as a pivotal defensive hedge securing the body from a range of external factors and implicit pitfalls[9]. Its large face area, roughly 1.7 square measures in an average person, allows it to effectively shield the body from microorganisms, ultraviolet (UV) radiation, chemicals, allergens, and water loss. This defensive function is vital for maintaining overall health and well- being[10]. Also, the skin also plays a part in regulating body temperature, sensation, and the conflation of vitamin D through exposure to sun. Taking care of the skin is essential to support its functions and maintain good health[11].

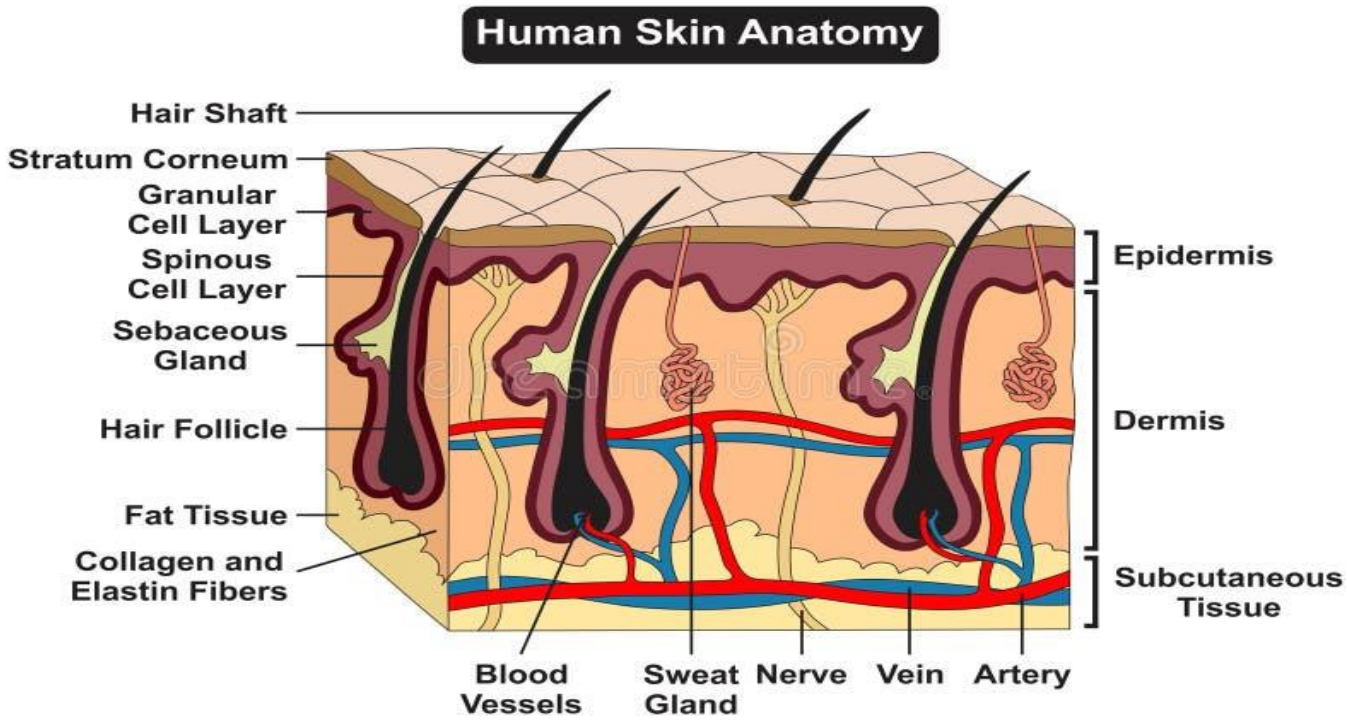

Figure1: Structure of the skin

The human skin is composed of three main types of tissues.

1. The Epidermis- According to cell size and the number of cell layers, the multilayered epidermis' consistence varies, ranging from 0.8 mm on the triumphs and soles to 0.06 mm on the eyelids. The stratum corneum occasionally appertained to as the wanton subcaste, is the skin's remotest subcaste. It's around 10 mm thick when dry, but when fully doused , it swells to a consistence that's several times more. It consists of 10 to 25 layers of corneocytes, which are dead, keratinized cells. It's adaptable and largely impermeable. The stratum corneum subcaste is the main asset of medicine entry. A wall- suchlike structure can be used to represent the wanton subcaste's structure. The lipid bit contains enough amphiphilic material, including cholesterol and polar free adipose acids, to keep the bilayer structure. The stratum corneum is covered by the feasible epidermis, which has a consistence that varies from 0.06 mm on the eyelids to 0.8 mm on the triumphs. There are numerous situations as you move inward, including the stratum rudimentary, stratum lucidum, stratum granulosum, and stratum spinosum. The epidermis is continuously renewed by rudimentary subcaste cells going through mitosis, and this addition makes up for the loss of dead horny cells from the skin's face. The rudimentary subcaste's cells suffer morphological and histochemical changes as they trip outward, driving keratinization to produce the stratum corneum's top subcaste[12].

2. The Dermis- The dermis is a subcaste of connective towel that's 3 to 5 mm thick and is made up of jitters, lymphatic vessels, and blood vessels. An essential element of controlling body temperature is the cutaneous blood force. While barring waste and adulterants, it also nourishes and oxygenates the skin. The skin's face is within 0.2 mm of capillaries, which offers Gomorrah conditions for the maturity of motes that cross the skin hedge. Because of the blood force, a percolate dermal attention is kept extremely low, and the preceding attention grade across the epidermis is pivotal for transdermal saturation.

3. The Hypodermis- The dermis and epidermis are supported by it. It serves as a place to store fat. This subcaste aids in maintaining body temperature, furnishing salutary support, and furnishing mechanical protection. Major blood vessels and sensitive organs for pressure may be present. While topical drug delivery only involves penetration through the stratum corneum and also requires medicine retention in the skin layers, transdermal medicine delivery frequently entails the penetration of the medicine through all three layers and into the systemic rotation[13].

Routes of Drug Penetration Through Skin

Drug penetration across the skin can do through two routes the transepidermal pathway, which involves penetration through the epidermis, and the transappendegeal pathway, which involves penetration through accessories similar as hair follicles and sweat glands.

1. Transepidermal Pathway: In this pathway, medicines percolate through the skin's remotest subcaste, known as the stratum corneum. This subcaste is a structurally complex, multi-layered, andmulti-cellular barrier[14].

a) Intra-cellular Route: Some medicines can go through specific skin cells called corneocytes, which are technical skin cells. This route is for substances that dissolve in water (hydrophilic or polar solutes).

b) Inter-cellular Route: Other medicines can move through the spaces between these skin cells. This route is for substances that dissolve in fats (lipophilic ornon-polar solutes). They travel through the nonstop adipose subcaste of the skin.

2. Transappendegeal Pathway: This pathway involves medicines passing through sweat glands and hair follicles in the skin.

a) Sweat Glands and Hair Follicles: These are like bitsy coverts or openings in the skin that some substances can travel through[15].

So, when medicines need to get into our body through the skin, they can either go through the external subcaste of skin cells or use these bitsy coverts created by sweat glands and hair follicles. Each pathway has specific characteristics, allowing different types of substances to enter the body[16].

Penetration Enhancers

Penetration enhancers, also appertained to as saturation enhancers or skin penetration enhancers, are substances employed to enhance the permeability of active composites, similar as medicines, through the skin. They serve by temporarily modifying the structure and parcels of the stratum corneum, the skin's remotest subcaste. This revision allows for better penetration of the active constituents into the bloodstream or deeper layers of the skin, enhancing the effectiveness of topical specifics.

Migraine

The word" migraine" is deduced from the Greek word" hemikrania," which means" half of the cranium," because the maturity of migraine victims will have a unilateral, palpitating or palpitating headache.

Frequent migraine symptoms include headache nausea or vomiting, perceptivity to light, sound, or smell, as well as ambiences — signs of brewing headaches. numerous people who suffer from migraines wake up in the early morning when their attack is formerly well underway and accompanied by nausea and vomiting. To treat migraines snappily and effectively, a novel, noninvasive, non-oral administration fashion is thus needed. An tenacious patch placed on the skin that contains drug that's intended to be absorbed into the bloodstream through the skin is called a transdermal patch, also known as a skin patch or skin patch[17].

Causes

Migraine are caused by a combination of inheritable, environmental and neurological factors. The exact medium is not completely understood, but the main causes and touched off include;

1. Genetic Factors

• A family history of migraine increase the liability of developing them.

2. Environmental and Lifestyle Triggers

- **Stress-** Emotional stress and anxiety can spark migraines.
- **Sleep Problems-** Lack of sleep or irregular sleep patterns.
- **Weather changes-** unforeseen changes in temperature, moisture, or barometric pressure.
- **Sensitive Stimuli-** Bright lights, loud sound and strong smell.

3. Neurological Causes

- Abnormal brain exertion affecting whim-whams signals, chemical, and blood vessels.
- Imbalance in neurotransmitters like serotonin, which regulate pain[18].

Transdermal Patch

A transdermal patch, also known as a skin tenacious patch, is a device designed to administer a precise lozenge of drug by placing it on the skin. This allows the medicine to be delivered through the skin and into the bloodstream. The technical membrane regulates the passage of liquid drug from the patch force through the skin and into the bloodstream[19]. multitudinous cases encounter challenges swallowing tablets or entering injections, and patches remain effective for further extended durations compared to tablets, so frequent dosing is reduced. Patches are employed in colorful remedial areas, similar as pain operation, heart complaint treatment, smoking conclusion, stir sickness operation, and hormone relief therapy[20].

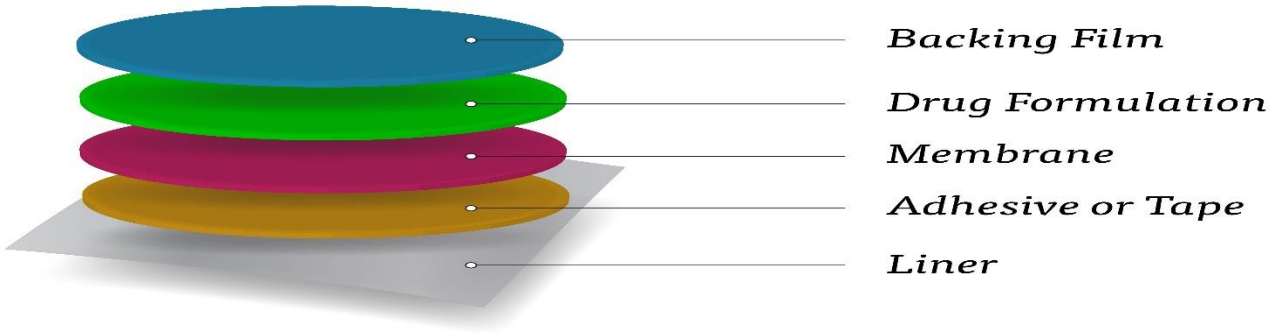

Figure 2: Transdermal patch

Criteria for selection of medicine for transdermal patch[21]
Dose: Should be low in weight (lower than 20mg/ day).
Half-life: 10/ lower (hrs.).
Molecular weight: 0.5*10- 3cm/ h
Skin response: non prickly, non-sensitizing
Oral bioavailability: low.

Components of transdermal patch
Drug- It's active component which is in direct contact with release liner.
Polymer- The polymer must parade both natural and chemical comity with medicines and other complements similar as saturation enhancers, plasticizers, bonds, etc.

Example:-
1. Natural polymers: Shellac, gelatin, chitosan, waxes, cellulose derivations, natural rubber.
2. Synthetic polymer: PVA, polyurea, polyamide, polyethylene, polyvinyl pyrrolidone, polypropylene. **3. Synthetic elastomer:** Polyurethane, polyisobutylene, polybutadiene, nitril, hydrin rubber, silicon rubber, butylrubber[22].

Backing Layer- It supports and protects the transdermal patches from the external terrain. To help medicine loss, the backing membrane must be elastic, flexible, and impermeable to medicine prolixity. It must be compatible with the polymer, excipients, and medicine. It's made of aluminium antipode, polyethene, polyester, polyvinyl chloride, heat-sealed layers, polyurethane, and contains an tenacious froth pad[23].

Rate Controlling Membrane- The rate at which a medicine is delivered from a lozenge form is determined by rate controlling membranes. A rate- controlling membrane is made from a variety of natural and synthetic polymers. For illustration- chitosan and poly2- hydroxyethyl methacrylate[24].

Adhesive- The main part of the glue in transdermal patches is to maintain contact with the skin for a prolonged period. Patch type, patch design, and tenacious characteristics are selection factors for patches. It must benon-irritating, suitable for skin and excipients, and simple to remove. Some exemplifications of bonds are silicon- grounded tenacious polymers, polyacrylate, and, polyisobutadiene[25].

Release liner- The release liner, which is a part of primary packaging, guards against both medicine loss from the polymer matrix and external terrain impurity of the patch during storehouse and shipping[26]. At the time of use, it's hulled off. For illustration-

- Occlusive- polyethene or Polyvinyl chloride
- Non-occlusive (paper fabric)- polyester antipode and metallic foil[27].

Plasticizers- Plasticizers increase the inflexibility and fineness of the polymer. When these are added, they alter the physical and mechanical parcels of the polymer. For illustration- Glycerol derivations, phthalic acid esters, sebacic acid esters, oleic acid esters, and alcohols-

- Increase polymer extension at break, durability, and inflexibility.
- Reduces tensile stress, hardness, electrostatic charge capability, and glass transition temperature[28].

Other excipients- Saturation enhancers are used to dissolve the medicine and polymers. Examples- methanol, chloroform, triethyl citrate, polyethene glycol, and propylene glycol[29].

Types of Transdermal Patches

a. **Single layer drug in adhesive:** In this type the tenacious subcaste contains the medicine. The tenacious subcaste not only serves to cleave the colorful layers together and also responsible for the releasing the medicine to the skin. The tenacious subcaste is girdled by a temporary liner and a backing[30].

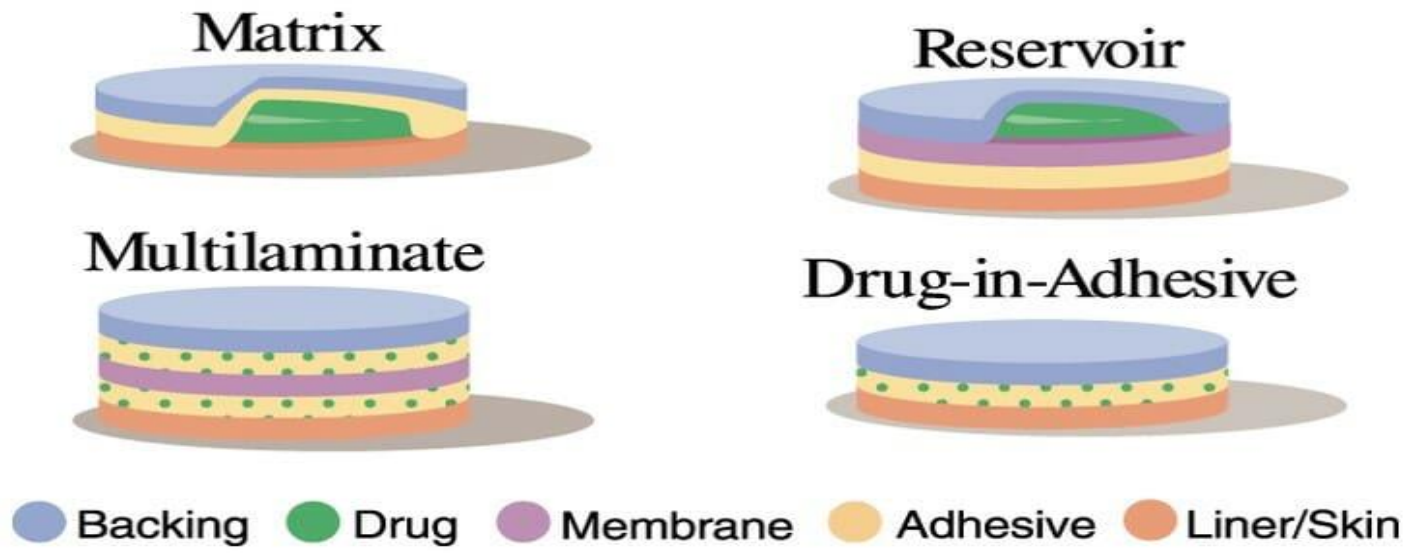

Figure 3: Types of transdermal patch

b. Multi- subcaste medicine in tenacious: This type is also analogous to the single subcaste but it contains an immediate medicine- release- subcaste and other subcaste will be a controlledrelease along with the tenacious subcaste. The tenacious subcaste is responsible for the releasing of the medicine. This patch also has a temporary liner subcaste and a endless backing.

c. Vapour patch: The patch containing the tenacious subcaste not only serves to cleave the colorful shells together but also serves as to release the vapour. The vapour patches are new to the request, generally used for releasing the essential canvases in decongestion. colorful other types of vapour patches are also available in the request which are used to ameliorate the quality of sleep and reduces the cigarette smoking conditions[31].

d. Reservoir system: In this system the medicine force is bedded between an impervious backing subcaste and a rate controlling membrane. The medicine releases only through the rate controlling membrane, which can be micro pervious ornon-porous. In the medicine force cube, the medicine can be in the form of a result, suspense, gel or dispersed in a solid polymer matrix[32].

Various methods for preparation of Transdermal patch

(A). Solvent costing method

• Drug and polymer are dissolved in suitable solvent.
• Plasticizer and permeation enhancer are added to above mixture step by step and mixed uniformly.
• The resulted uniform solution is cast into the Petri dish which was lubricated with glycerin and dried at room temperature for 24hrs.
• A inverted funnel was place on the Petri dish to prevent fast evaporation.

(B). Mercury substrate method

• Drug is dissolved in polymer solution along with plasticizer.
• Stir for 10 to 15 minutes to produce a homogeneous dispersion.
• Pour it into a labeled mercury surface, covered with inverted funnel to control solvent evaporation.

(C). IPM membrane method

• Drug is dispersed in a mixture of water and propylene glycol containing carbomer 940 polymer.
• Stir for 12 hours in magnetic stirrer.
• Dispersion is to be neutralized and made viscous by the addition of triethanolamine.
• Buffer pH 7.4 can be used in order to obtain solution gel.

• The formed gel will be incorporated in the IPM membrane.

(D). Circular teflon mould method

• Polymer solution (in various ratio) and Organic Solvent.
• Drug dissolves in half amount of same organic solvent (in different concentration) + different ratio of the drug and solvent.
• Addition of Di-N-butylphthalate.
• Stir 12 hours and pour into Circular teflon mould.
• The solvent is allowed to evaporate for 24 hours.
• The dried films are to be stored for another 24 hours in a desiccators containing silica gel before evaluation to eliminate aging effect.
• The type films are to be evaluated within 1 week of their preparation[33].

Future of Transdermal Drug Delivery System:

Future aspects in medicine delivery system include liposomes, Niosomes and micro conflation. Aim of this development is to ameliorate delivery of medicine that has low essential solubility in utmost of classical expression excipients. A wide range of implicit medicines for delivery like steroids, antifungal, antibacterial, interferon, methotrexate, original anesthetics are formulated. The request for transdermal patches has been estimated to increase in future and has lately endured periodic growth of at rate of 25%.

Transdermal drug delivery system used with different drug

Drug	Indication
Estradiol	Postmenstrual syndrome
Testosterone	Hypogonadism in males
Clonidine	Hypertension
Estradiol	Postmenstrual syndrome
Estradiol	Postmenstrual syndrome
Nitroglycerine	Angina pectoris
Fentanyl	Moderate / severe pain
Estradiol	Postmenstrual syndrome
Estradiol	Postmenstrual syndrome
Fentanyl	Pain relief patch
Nitroglycerine	Angina pectoris
Nicotine	Smoking cessation
Nicotine	Pharmacological smoking cessation
Nitroglycerine	Angina pectoris
Nitroglycerine	Angina pectoris
Rigotine	Early – stage idiopathic Parkinson's disease
Diclofenac diethylamine	Anti-Inflammatory
Estrogen / Progesterone	Hormone replacement therapy
Norelgostromin / Ethinyl Estradiol	Postmenstrual syndrome
Oxybutynin	Overactive bladder
Nicotine	Smoking cessation
Testosterone	Hypogonadism in males
Nitroglycerine	Angina pectoris
Scopolamine	Motion sickness

CONCLUSION

In compared to further conventional ways, transdermal medicine delivery is a well- established route of administration that offers a number of advantages, including convenience, regulated and sustained distribution, and avoidance of the gastrointestinal tract. Given that the current oral, nasal, and subcutaneous phrasings each have their own downsides, migraines may find these advantages to be appealing. Triptan is one of the more constantly specified migraine treatments, but new technologies, like the Zelrix iontophoresis patch, may give migraine victims other remedial options. Only a many exploration have been done on TDDSs for migraine. still, because of its multitudinous benefits thathave been demonstrated, it is necessary to further probe this system and its route of administration because, in addition to being remedial[34].

REFERANCES

1.Allen LV, Popovich NG, Howard C. Ansel. Pharmaceutical dosage forms and drug delivery systems, 8th Edn. New Delhi: Wolter Kluwer Publishers; 2005. p. 298–9.

2.Kumar P, Sankar C, Mishra B. Delivery of macromolecules through skin. Indian Pharm. 2004;5(3):7– 17.

3.Hanbali OA, Khan HMS, Sarfraz M, Arafat M, Ijaz S, Hameed A, et al. Transdermal patches: Design and current approaches to painless drug delivery. Acta Pharm. 2019;69(2):197–15.

4.Premjeet S, Bilandi A, Sahil K, Akanksha M, Bihani SG, "Transdermal drug delivery system (patches), applications in the present scenario" Int J Res Pharm Chem, 2011; 1(4):1139-51.

5.Patel D, Chaudhary SA, Parmar B, Bhura N, "Transdermal Drug Delivery System: A review" The Pharma Innovation, 2012; 1(4):66-75.

6.Shingade G, "Review on Recent Trend on Transdermal Drug Delivery System" Journal of Drug Delivery and Therapeutics, 2012; 2(1):66-75.

7.Sharma N, Parashar B, Sharma S, Mahajan U, "Blooming pharma industry with transdermal drug delivery system" Indo Global J Pharm Sci, 2012; 2(3):262-78.

8.Mali AD, Bathe RS, Patil MK, "An updated review on transdermal drug delivery systems" International Journal of Advances in Scientific Research, 2015; 8(9):244.

9.Williams AC, Barry BW. Penetration enhancers. Adv Drug Deliv Rev. 2012;64(5):128–18.

10.Menon GK. New insights into skin structure: scratching the surface. Adv Drug Deliv Rev. 2002;54(1):3–17.

11.Benson HA, Watkinson AC. Topical and Transdermal Drug Delivery: Principles and Practice. Hoboken, NJ, USA: Wiley; 2012.

12.Tsai CJ, Hsu LR, Fang JY, LIN HH, "Chitosan hydrogel as a base for transdermal delivery of berberine and its evaluation in rat skin" Biological and Pharmaceutical Bulletin, 1999; 22(4):397-401.

13.Shivhare S, Jain AP, Jain T, Vishwakarma R, Vishwakarma P, Prajapati S, Jain A, Formulation, Development and Characterization of Transdermal Patches of Glipizide. International Journal of Medical Sciences and Pharma Research, 2022; 8(3):1-7.

14.Schuetz YB, Naik A, Guy RH, Kalia YN. Emerging strategies for the transdermal delivery of peptide and protein drugs. Expert Opin Drug Deliv. 2005;2(3):533–48.

15.Schoellhammer CM, Blankschtein D, Langer R. Skin Permeabilization for Transdermal Drug Delivery: Recent Advances and Future Prospects. Expert Opin Drug Deliv. 2014;11(3):393–407.

16.Shahzad Y, Louw R, Gerber M, Plessis JD. Breaching the Skin Barrier through Temperature Modulations. J Control Release. 2015;202:1–13. doi:10.1016/j.jconrel.2015.01.019.

17.Silberstein SD. Practice parameter: evidencebased guidelines for migraine headache (an evidencebased review): report of the Quality Standards Subcommittee of the American Academy of Neurology. Neurology 2000;55:754 –762.

18.Hwang I, Kim HN, Seong M, Lee S, Kang M, Yi H, et al. Multifunctional Smart Skin Adhesive Patches for Advanced Health Care. Adv Health Mater. 2018;7(15):1800275. doi:10.1002/adhm.201800275.

19.Saroha K, Yadav B, Sharma B. Transdermal patch: A discrete dosage form. Int J Curr Pharm Res. 2011;3(3):98–108.

20.Jain NK. Transdermal Drug Delivery. In: Introduction To Novel Drug Delivery System. Vallabh Prakashan;. p. 97–115.

21.Rao PR, Diwan PV, "Permeability studies of cellulose acetate free films for transdermal use: Influence of plasticizers" Pharmaceutica Acta Helvetiae, 1997; 72(1):47-51.

22.Ghosh S, Das S, Singh A, Gupta S. Applicability Of Natural Polymer And Natural Permeation Enhancer In Transdermal Drug Delivery System: A Detailed Review. Int J Innov Pharm Sci Res. 2021;9(8):1– 24.

23.Saroha K, Yadav B, Sharma B, "Transdermal patch: A discrete dosage form" Int J Curr Pharm Res, 2011; 3(3):98-108.

24.Parivesh S, Dwivedi S, Dwivedi A, "Design, Evaluation, Parameters and Marketed Products of transdermal patches: A Review" J Pharm Res, 2010; 3(2): 235-240.

25.Sun YM, Huang JJ, Lin FC, Lai JY, "Composite poly (2-hydroxyethyl methacrylate) membranes as rate-controlling barriers for transdermal applications" Biomaterials, 1997 Apr 1; 18(7):527- 533.

26.Kandavilli S, Nair V, Panchagnula R, "Polymers in transdermal drug delivery systems" Pharmaceutical technology, 2002; 26(5):62-81.

27.Jain NK "Controlled and Novel Drug Delivery" First Edition, CBS Publishers and Distributors, New Delhi, 1997; 100-129.

28.Ahmed A, Karki N, Charde R, Charde M, Gandhare B, "Transdermal Drug Delivery Systems: An Overview" International Journal of Biological Advances and Research, 2011; 2:38-56.

29.Patani GA, Chien YW. In, Swerbrick, J, Boylon, JC, "Encyclopedia of Pharmaceutical Technology" 1999; 18:317-329.

30.Silberstein SD. Migraine symptoms: results of a survey of selfreported migraineurs. Headache 1995;35:387–396.

31.Ajina CT, Charyulu NR, Sandeep DS. Rizatriptan transdermal patches for the treatment of migraine. Research Journal of Pharmacy and Technology. 2018;11(3):873- 8.

32.Pierce MW. Transdermal delivery of sumatriptan for the treatment of acute migraine. Neurotherapeutics. 2010 Apr;7(2):159-63.

33. Tiwari Chanchal, Chaudhary Mahima, Malik Princy, Jaiswal Pankaj Kumar, Chauhan Reetu, A Review on Transdermal Patch: A Novel Approach for Transdermal Drug Delivery, Journal of Drug Delivery and Therapeutics, 2022;12(6):179-188.

34.Jameel Aasim Shaikh, Quzi Majaz A, Jameel Shaikh Aatif, A Review on Preparation and Evaluation of targeted Transdermal Drug Delivery System, In the treatment of migraine, International Journal of pharmaceutical sciences, 2024;2(4): 915-924.