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An Overview On Transdermal Drug Delivery System: Transdermal Patches

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Abstract: *Transdermal drug delivery systems were developed as a solution to the problems with traditional drug administration techniques, especially the oral route. A transdermal patch is an adhesive patch that is applied specifically to the skin's surface. intended to deliver a particular quantity of medication via the skin and into the circulation. This strategy promotes healing in certain parts of the body that would otherwise be challenging to access. A noteworthy benefit transdermal medication administration in contrast to alternative techniques like oral, its administration via topical, intravenous (IV), and intramuscular (IM) routes medicine is administered to the patient under regulated circumstances. Either a permeable membrane enclosing a medicine reservoir or the patient's body heat are used to produce this regulated release. to melt tiny drug layers that are enmeshed in the glue. Though it has advantages, transdermal Because of the skin's efficient barrier function, medication transport is limited in some ways. Just the Smaller molecules are more effectively absorbed by the skin and can therefore be given the means of this technique. This extensive evaluation explores the origins of transdermal patches, including patch design, patch manufacture, and difficulties associated with efficient drug delivery, among other things..*

Keywords: TDDS, Transdermal patch, methods of preparation, uses

I. INTRODUCTION

Transdermal drug delivery is an alternative way of delivering drugs via the skin layer[]. The drug is carried through the skin into the bloodstream and circulates systemically in the body before reaching the target site [1,2]. The transdermal drug delivery method has several advantages over other routes of administration. Examples include the ability to deliver continuous doses of drugs over an extended period of time, the ability to bypass the digestive system, and the ability to avoid first-pass metabolism in the liver [3]. Other drug administration routes, such as intravenous, can cause pain and increase the risk of infection. In view of its advantages over other routes, transdermal administration is commonly used to deliver drugs for conditions such as smoking cessation, chronic pain, and motion sickness, as well as hormone replacement therapy [4,5,6].

Transdermal patches, available in diverse sizes and compositions, adhere to the skin's surface. Through this interface, they release active pharmaceutical ingredients into the bloodstream, traversing the skin's barriers. A reservoir containing a concentrated drug dose is held against the skin for an extended period, allowing gradual entry into the circulatory system via the process of diffusion.

II. DRUG CAN PENETRATE THROUGH SKIN VIA THREE PATHWAYS

a) Through hair follicles.
b) Through sebaceous glands.
c) Through sweat duct.

Transdermal drug delivery systems are employed in varied skin disorders, conjointly within the management of angina pectoris, pains, smoking stop & medical specialty disorders corresponding to Parkinson's un wellness. [7,8]

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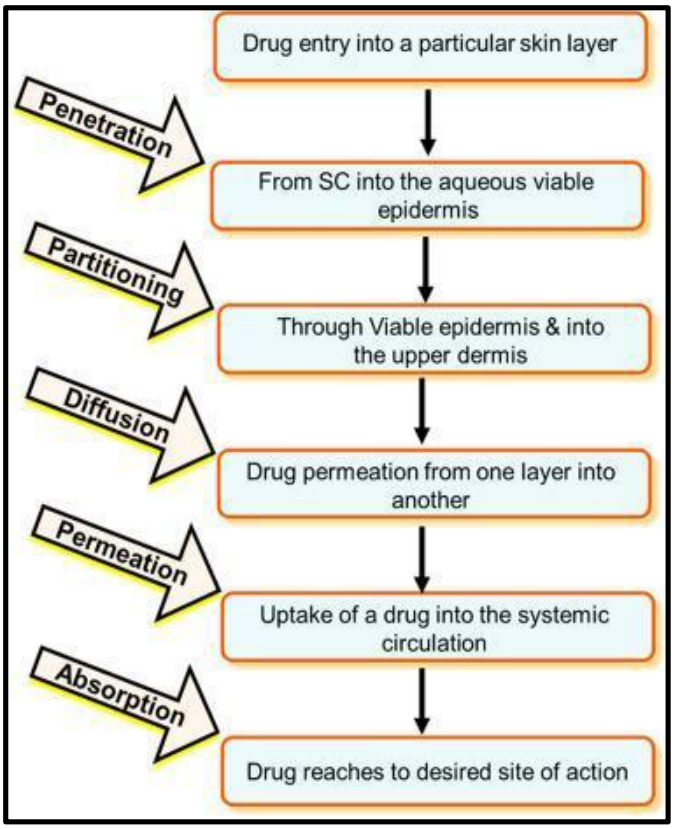

Fig-1. Drug penetration through skin

Limitation of TDDS

- Ionic medicines can't be delivered using TDDS.
- High drug levels in the blood or plasma cannot be reached with TDDS.
- It cannot grow for medications with big molecular weights.
- Cardiac drug delivery is not possible with TDDS.
- If a medication or formulation irritates the skin, TDDS cannot occur.

Uses

- The nicotine patch, which distributes nicotine in regulated dosages to aid in quitting smoking, is the most popular transdermal patch in the US. In Europe, the first vaping patch for quitting smoking was authorized in 2007.
- Fentanyl (sold under the brand name Duragesic) and buprenorphine are two opioid drugs that are frequently used in patch form to treat chronic pain (marketed as Bu Trans).
- Menopausal symptoms and postmenopausal osteoporosis may both be treated with estrogen patches.
- The contraceptive patch is one of the additional transdermal patches for hormone administration (marketed as Ortho Evra or Evra).
- In certain cases, nitroglycerine patches rather than sublingual tablets are recommended for the treatment of angina.
- Under the trade name Catapres-TTS, clonidine, an antihypertensive medication, is offered as a transdermal patch.

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- In March 2006, Emsam, a transdermal formulation of the MAOI selegiline, was authorized for use in the United States as the first transdermal delivery agent for an antidepressant.

III. TRANSDERMAL PATCHES

Transdermal patches are adhesive drug delivery systems designed to deliver medications through the skin and into the bloodstream. They provide a non-invasive route for systemic administration, allowing for controlled and sustained release of active ingredients over time.

3.1. Key Properties:

Composition: Typically made of a backing layer (for structural support), a drug reservoir or matrix (containing the active ingredient), and an adhesive layer (to attach the patch to the skin).
Mechanism of Action: The drug is absorbed through the skin layers and enters the systemic circulation. This is often facilitated by skin penetration enhancers or micro-needles in some advanced formulations.
Release Rate: Designed to provide a steady release of the drug, which can improve patient adherence and minimize side effects compared to oral or injectable forms.
Application Sites: Commonly applied to areas such as the upper arm, chest, or back where the skin is relatively thin.
Duration of Action: Can vary from hours to several days, depending on the formulation and the drug being delivered.
Benefits: Non-invasive, reduced gastrointestinal side effects, bypassing first-pass metabolism, and improved patient compliance due to ease of use.
Transdermal patches are used for various therapeutic purposes, including pain management, hormone replacement, and smoking cessation.

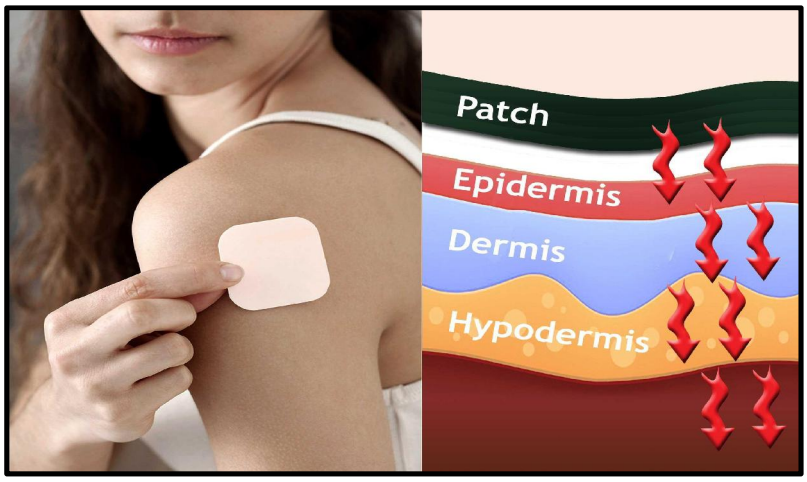

Fig-2. Transdermal patch with layers of skin

3.2.Types of Transdermal Patches

In general, there are four main types of transdermal medical patches (drug-in adhesive, reservoir, matrix, and micro-reservoir systems), as shown in Figure 2. Most commercially available patches are categorized as reservoir or matrix systems. [10].

(A) drug-in adhesive system
(B) Reservoir system
(C) matrix system
(D) Micro-reservoir system.

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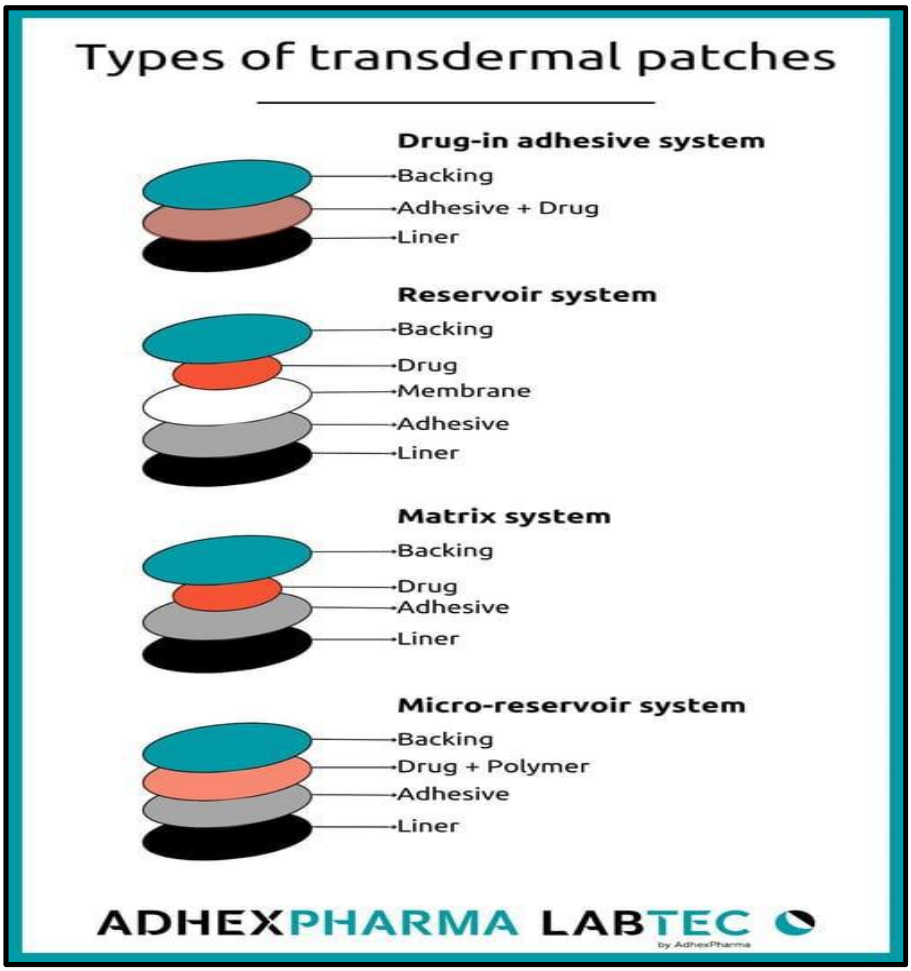

Fig-3. Types of transdermal patches

3.2.1.Drug-in-Adhesive System

This is the simplest form of membrane permeation control system. The adhesive layer in this system contains drugs and serves to glue the different layers together. The drug mixture is sandwiched between the liner and backing.

3.2.2.Reservoir System

In this system, the drug reservoir is held between the backing layer and the rate-controlling membrane, and the drug is released through the microporous rate-controlling membrane. The drug can be in solution, suspension, or gel form, or can be dispersed in a solid polymer matrix within the reservoir chamber.

3.2.3.Matrix System

Drugs are uniformly dispersed in hydrophilic or lipophilic polymer matrices. The resulting drug-containing polymer is affixed to drug-containing discs of controlled thickness and surface area.

3.2.4.Micro-Reservoir System

This system is a combination of reservoir and matrix dispersion system. Here, the drug is prepared by first suspending drug solids in an aqueous solution of a water-soluble liquid
polymer and then uniformly dispersing the solution in a lipophilic polymer to create thousands of non-leaching microscopic drug reservoirs.

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3.3.Material used for Transdermal patches:

1. Active Ingredient:

Drug substance (e.g., nicotine, fentanyl, or another active compound)
Quantity: Typically, 1-10% of the total patch weight, depending on the drug's potency.

2. Polymer Matrix:

Hydrophobic Polymers: (e.g., silicone, polyurethane)
Hydrophilic Polymers: (e.g., PVP, hydroxypropyl cellulose) Quantity: 60-80% of total patch weight.

3. Permeation Enhancers:

(e.g., ethanol, oleic acid, or surfactants) Quantity: 1-10% of total patch weight.

4. Plasticizers:

(e.g., dibutyl phthalate, glycerin) Quantity: 5-15% of total patch weight to improve flexibility.

5. Adhesive:

(e.g., acrylate copolymers) Quantity: 10-20% of total patch weight for effective skin adhesion.

6. Fillers:

(e.g., talc or calcium carbonate) Quantity: Adjust based on desired thickness and mechanical properties.

3.3.1.Example Calculation

Let's say you want to prepare 100 grams of a transdermal patch:
Each patch contains = 1 mg

Table-Formula for preparing transdermal patch:

Sr. No.	Ingredients	Quantity
1	API- Lidocaine hydrochloride	5 mg
2	Polymer matrix - ethyl cellulose	10 mg
3	Permeation Enhancer-oleic acid	2 mg
4	Plasticizer-diethyl phthalate	5 mg
5	Stabilizer- sodium benzoate	0.5 mg
6	Fillers- talc	5 mg
7	Antioxidants -vitamin-E	1 mg
8	Solvent -ethanol	Q.s.10 mg

3.3.2. Procedure

- **Mix the Active Ingredient:** Combine the active ingredient with the permeation enhancer and mix thoroughly.
- **Polymer Solution:** Dissolve the polymers in a suitable solvent (e.g., ethanol or a mixture of solvents) until a homogeneous solution is achieved.

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- **Combine Mixtures**: Slowly add the active ingredient mixture to the polymer solution while stirring continuously.
- **Add Plasticizer and Adhesive:** Incorporate plasticizers and adhesives into the mixture and mix well.
- **Casting:** Pour the mixture onto a flat surface or mold to form patches of the desired thickness.
- **Drying:** Allow the patches to dry completely, which may involve ambient air drying or controlled oven drying.
- **Cutting and Packaging**: Once dried, cut the patches to the desired size and package them appropriately.

Safety and Testing

Ensure to conduct stability and release rate testing. Consider the skin permeability and potential irritations.

3.4.Situations where transdermal patches are applied

When a transdermal patch is applied:

1. When a patient needs an alternate drug delivery mechanism because they are experiencing unbearable side effects, such as constipation, and they are unable to swallow oral medications due to dysphagia.
2. Situations in which effective management might result in better pain control. Patients with cognitive impairment or those who are unable to self-medicate with their analgesics for other reasons may find this helpful.
3. It may be used with other enhancement techniques to have a multiplicative impact[13'14].

3.5. Medicinal uses of transdermal patches:

- **Pain Management**: Patches like fentanyl or buprenorphine are used to manage chronic pain, providing continuous drug delivery over an extended period.
- **Hormonal Therapies:** Hormone replacement therapies (e.g., estrogen patches) are used for menopause management, providing a steady release of hormones.
- **Nicotine Replacement**: Nicotine patches help individuals quit smoking by delivering controlled doses of nicotine to reduce withdrawal symptoms.
- **Cardiovascular Medications**: Patches delivering medications like nitroglycerin can help manage angina by providing a steady release of the drug to improve blood flow.
- **Antidepressants and Anxiolytics**: Some patches, like those delivering selegiline, can be used for conditions such as depression or anxiety.
- **Anti-nausea:** Scopolamine patches are commonly used to prevent nausea and motion sickness.
- **Vaccinations**: Research is ongoing into patches for delivering vaccines, which could simplify administration and improve uptake.
- **Local Anesthetics**: Lidocaine patches can be used for localized pain relief, often for conditions like postherpetic neuralgia.

Therapeutic value of many drugs get increased by avoiding problems associated with drug like lower absorption, GI irritation, decomposition due to hepatic first pass metabolism. [11,12]

3.6. Recent Advancement of Transdermal Patch

Traditional transdermal patches serve only two purposes: storage and release of drugs. While this method has some advantages, traditional patching has many challenges and drawbacks, for example limited dosage or low release.

To date, there have been several advances in the field of transdermal drug delivery.

These include the design of novel patches, which include the ability to sense and release drugs accurately, higher loading, and enhanced penetration and release of drugs.

Overall, the field of transdermal drug delivery is an active area of research and development, with many exciting new developments on the horizon, as discussed below.

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IV. CONCLUSION

With numerous benefits over alternative administration methods, transdermal patch technology is a useful drug delivery technique. Patches can deliver continuous drug dosing for a longer amount of time by avoiding the first-pass metabolism and digestive system. They are frequently used to administer medications for a range of conditions, including hormone replacement therapy, chronic pain, and motion sickness. Transdermal patch technology has advanced significantly in recent years, with the creation of smart, biodegradable/solvent, high-loading/release, and 3D-printed patches among its numerous innovations. Although transdermal patches hold promise as a convenient and efficient drug delivery method for a range of conditions, there are a few obstacles that need to be addressed. These include the potential for self-inflicted toxicity due to incorrect dosing, poor adhesion, low drug penetration, and potential trigger for skin irritation.

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