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# A Review on Transdermal drug delivery systems

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**ABSTRACT**
Transdermal drug delivery systems (TDDS) are an effective way to treat illnesses without relying on pills or injections. The inclusion of microneedles in these patches enhances drug penetration, making them particularly valuable for addressing viral infections. These patches, especially with microneedles, bring benefits such as enhanced vaccine delivery, less waste, and simpler self-administration. They present a viable option for treating widespread viral diseases, delivering targeted treatment with fewer side effects. Additionally, they serve for quick and minimally invasive disease testing, proving useful for on-the-spot diagnostics. In simpler terms, these patches, especially those with microneedles, have unique features that can combat viral infections and contribute to better global health.
**Keywords**:- Transdermal drug delivery,

## I. INTRODUCTION:

Patches, known as Transdermal Drug Delivery Systems (TDDS), are a modern way to give medicine through the skin. They have benefits like making sure patients take their medicine as directed and avoiding the liver's initial processing of the drug. These patches release medication in a controlled way, which is helpful for short-term medications, ensuring a steady level of the drug in the body. The first patch, Transderm-SCOP, got FDA approval in 1979, mainly for preventing nausea during travel. These patches typically include the drug, protective layers, and adhesive for sticking to the skin, marking a significant improvement in drug delivery.

**Advantage**

1. Alternative Route: Ideal for patients who can't tolerate oral medications, such as those prone to vomiting.
2. Enhanced Therapeutic Value: Increases the effectiveness of many drugs by avoiding issues like gastrointestinal irritation, low absorption, and drug interactions.
3. Bypasses Liver Metabolism: Avoids first-pass metabolism as the drug is absorbed directly through the skin.
4. Self-Administration:Allows patients to administer the medication themselves, and it's noninvasive, eliminating the inconvenience of injections.
5. In emergencies, like when someone is unresponsive or unconscious, transdermal medication patches are quickly recognizable due to their physical appearance, features, and markings.

**Disadvantage**

1. Large drugs (more than 500 Dalton) aren't suitable for transdermal patches.
2. High concentrations of drugs can irritate the skin.
3. It's challenging to achieve high levels of the drug in the bloodstream.
4. Using patches for a long time can be uncomfortable for patients.
5. Drugs with extremely low or high partition coefficients struggle to reach the bloodstream.

**Anatomy of skin**

1.Epidermis:Outermost layer, like a protective wall.Varies in thickness, thickest on palms and thinnest on eyelids.Outer layer called "stratum corneum," like a barrier.Made of dead cells (corneocytes) and lipid "mortar."Acts as a barrier for drugs.

2.Dermis:3 to 5 mm thick layer below epidermis.Contains connective tissue, blood vessels, lymph vessels, and nerves.Blood supply regulates temperature, provides nutrients, and removes toxins.Essential for transdermal drug permeation

3.Hypodermis:Supports dermis and epidermis.Stores fat, regulates temperature, and provides protection.Carries blood vessels and

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nerves to the skin.Important for transdermal drug delivery.

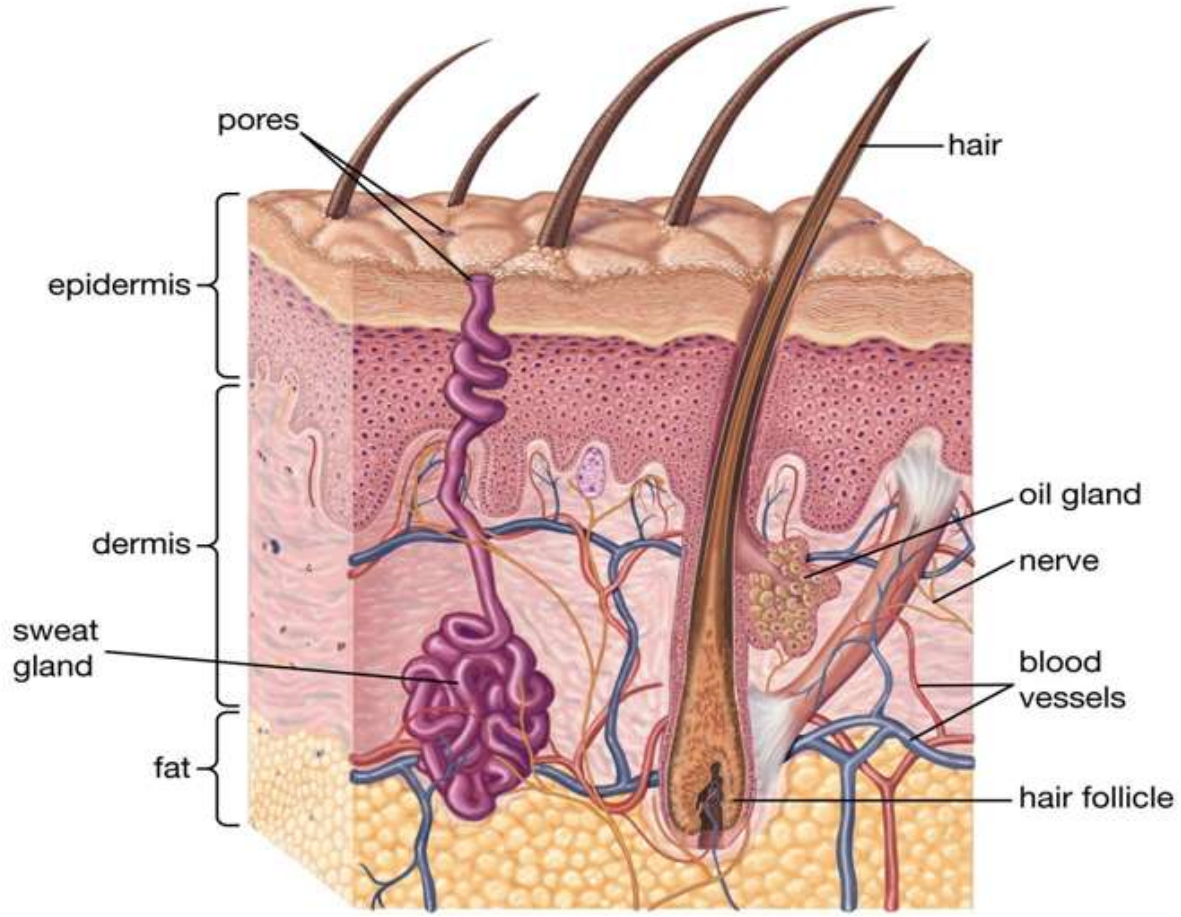


**Fig antomy of skin**

**Key Functions**:Epidermis constantly renews through cell mitosis.
Dermis provides essential blood supply, regulating temperature.
Hypodermis supports, protects, and stores fat.

**Principal of transdermal drug delivery systems**

1. Reservoir Diffusion: Drugs move from the drug reservoir to the rate-controlling membrane within the transdermal patch.
2. Membrane Diffusion: Subsequently, the drug diffuses through the rate-controlling membrane and reaches the outer layer of the skin, known as the stratum corneum.
3. Stratum Corneum Sorption and Penetration: The drug is sorbed by the stratum corneum (the outermost layer of the skin) and penetrates through the viable epidermis
4. Target Organ Impact: Finally, the absorbed drug enters the systemic circulation, affecting the target organ and exerting its therapeutic effect.

**Different types of transdermal patches**

**1. Single-layer Drug-in-Adhesive:**

The drug is integrated into the adhesive layer, which not only sticks the layers and the system to the skin but also facilitates drug release. A temporary liner and backing surround the adhesive layer.

**2. Multi-layer Drug-in-Adhesive**:

Similar to the single-layer approach, both adhesive layers in the multi-layer system are responsible for drug release. However, this system adds an extra layer of drug-in-adhesive, often separated by a membrane. It includes a temporary liner and permanent backing.

**3. Reservoir:**

Unlike single-layer and multi-layer drug-in-adhesive systems, the reservoir transdermal system features a distinct drug layer. This liquid compartment contains a drug solution or suspension, separated by the adhesive layer. The

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patch is backed by another layer. The release rate follows a zero-order pattern.

**4. Matrix**:

The Matrix system comprises a drug layer in a semisolid matrix with a drug solution or suspension. The adhesive layer surrounds the drug layer, partially overlaying it.

**5. Vapour Patch**:

The adhesive layer not only binds the layers but also releases vapors. Vapour patches, a recent introduction to the market, emit essential oils for up to 6 hours. These patches find use in cases of decongestion. Other variations include controller vapour patches enhancing sleep quality and those reducing monthly cigarette consumption.

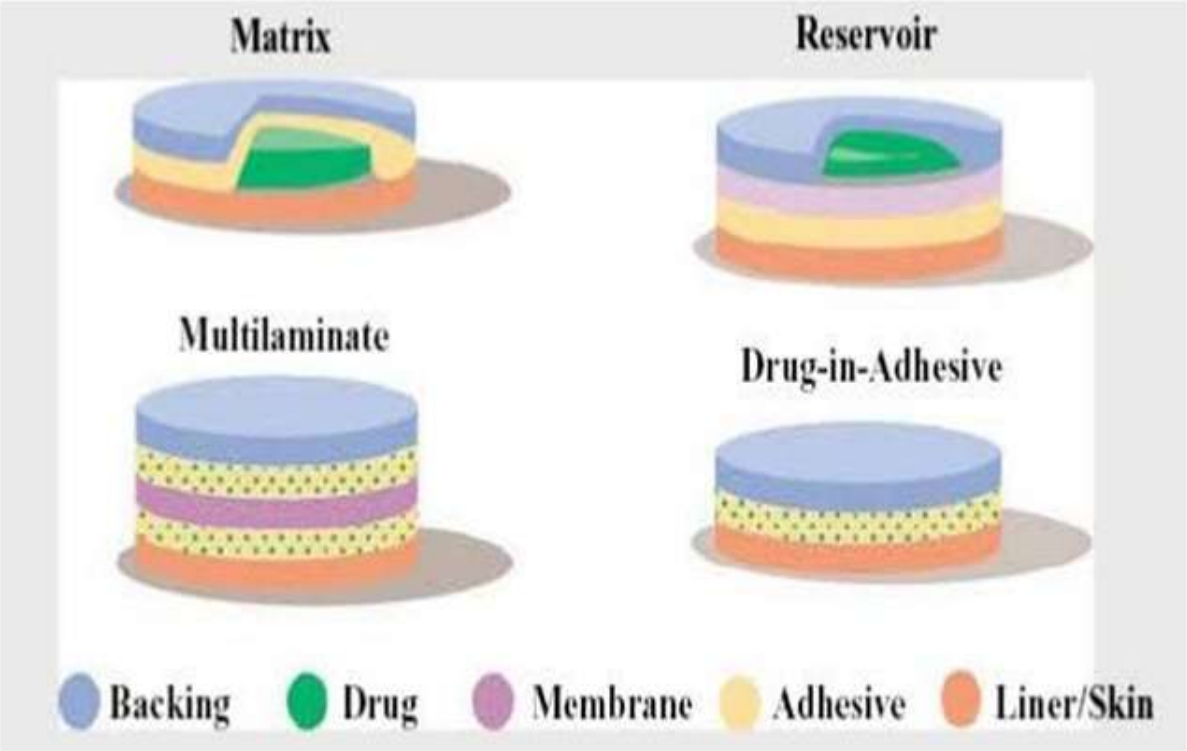


**Fig Different types of patches**

**Biopharmaceutical parameters drug selection for transdermal patch**

1. Low Dose:Opt for a dose below 20mg per day.
2. Short Half-life: Choose drugs with a half-life of 10 hours or less.
3. Moderate Molecular Weight:Prefer drugs with a molecular weight below 400.

4. Specific Partition Coefficient: The drug's partition coefficient (Log P) between octanol and water should be between 1.0 and 4.
5. Limited Skin Permeability: The skin permeability coefficient should be less than 0.5 X 10-3cm/h.
6. Skin-Friendly:Ensure the drug is non-irritating and non-sensitizing to the skin.
7. Low Oral Bioavailability:Select drugs with low oral bioavailability.
8. Limited Therapeutic Index:Consider drugs with a low therapeutic index.

The development of transdermal patches involves various approaches to effectively deliver drugs through the skin:

1. Matrix System: This approach disperses the drug uniformly in a polymer matrix, allowing for controlled and sustained release over time.
2. Reservoir System: In this method, a drug reservoir is formed, typically separated from the skin by a semipermeable membrane. The membrane controls the release of the drug, providing a more precise delivery mechanism.
3. Drug-in-Adhesive System: The drug is combined with an adhesive, forming a sticky layer that adheres to the skin. This system

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simplifies application while ensuring controlled drug release.
4. Matrix-Reservoir Hybrid System: Combining features of both matrix and reservoir systems, this approach offers a balance between controlled release and flexibility in drug loading.

**Application of transdermal drug delivery systems**

1. Pain Management:Transdermal patches are often used for delivering analgesics, such as opioids or nonsteroidal anti-inflammatory drugs (NSAIDs), for chronic pain management2. Hormone Replacement Therapy (HRT):Transdermal patches are utilized to deliver hormones, like estrogen and progesterone, in hormone replacement therapies for menopausal symptoms.
3. Nicotine Replacement Therapy (NRT): Transdermal nicotine patches are widely employed to help individuals quit smoking by providing a controlled and continuous release of nicotine.
4. Cardiovascular Medications:Transdermal delivery is used for drugs treating cardiovascular conditions, such as nitroglycerin for angina.5. Neurological Disorders: Medications for neurological conditions like Parkinson's disease and Alzheimer's may be administered through transdermal patches.
6. Motion Sickness:Scopolamine patches are used to prevent motion sickness by delivering the drug through the skin.
7. Contraception:Hormonal contraceptives can be administered through transdermal patches, providing an alternative to oral contraceptives.
8. Anti-Inflammatory Medications:Transdermal delivery systems are employed for delivering anti-inflammatory drugs for localized pain relief.
9. Dermatological Conditions: Certain medications for skin conditions, like corticosteroids for psoriasis, can be delivered through transdermal systems.
10. Insulin Delivery: Research is ongoing for developing transdermal insulin delivery systems for diabetes management.

**Recent advancements in transdermal patches:-**

1. Protein Delivery Patches: New technology allows the delivery of large proteins through printed patches. These patches contain dry doses of proteins that dissolve in the skin, facilitating their delivery.
2. Painless Diabetic Monitoring: A small patch with micro-heating elements allows painless and bloodless monitoring for diabetics. It breaches the skin surface, enabling access to interstitial fluid for analysis.
3. Testosterone Patch for Premature Ovarian Failure: A transdermal patch system delivers testosterone to young women with spontaneous premature ovarian failure, aiming to maintain normal hormone levels.
4. Oxybutynin Patch for Overactive Bladder:A clear patch called OXYTROL offers continuous bladder control for overactive bladder patients with fewer side effects than oral formulations.
5. Nanotechnology with Microneedles:Advances include microneedles that combine the benefits of needles and patches. These tiny needles allow controlled drug delivery, potentially modulating the immune system.
6. Pain Relief Patches: Transdermal patches, like Duragesic and Lidoderm, provide pain relief. Technologies like E-Trans fentanyl HCl deliver narcotic pulses for effective pain control.
7. Molecular Absorption Enhancement: Research explores compounds like terpene derivatives to enhance drug absorption through the skin, improving transdermal delivery.
8. Future Technologies:ThermalPoration involves creating aqueous pathways using pulsed heat, while jet injectors and small needles show promise for controlled, needle-free drug injection. Combinations of technologies like electroporation, iontophoresis, and ultrasound are also being explored.

## II. CONCLUSION

Nowadays, transdermal drug delivery systems (TDDS) are widely used to administer drugs directly into the bloodstream without causing pain or breaking the skin. This article provides important information about creating and assessing patches that deliver medication through the skin. By turning drugs into these patches, we can address challenges linked to current popular delivery methods. Advanced techniques in TDDS suggest it could become a leading and innovative drug delivery system in the future.

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