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REVIEW OF THE EXPANDING ROLE OF PATCH IN MODERN HEALTHCARE

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1:- ABSTRACT

Transdermal patches offer a non-invasive and patient-friendly alternative to traditional drug delivery routes, by delivering a controlled dose of medication through the skin into the bloodstream. The review article by Wongetal. (2023) explores the evolution of medical patches for transdermal drug delivery, beginning with conventional systems and culminating in recent innovations. Major innovations include dissolvable and biodegradable patches, systems with enhanced drug loading and release, microneedle-based platforms, and 3D- printed patches capable of delivering a wider range of therapeutics such as biologics. The paper highlights how these emerging technologies aim to overcome limitations such as poor skin barrier permeability, first-pass metabolism, and the need for frequent dosing. The review concludes with a discussion of future challenges and opportunities in designing next-generation transdermal patches that are smarter, more adaptable and capable of delivering complex therapies.

KEYWORD: Microneedle technology, Biodegradable patches, Dissolvable patches, 3D-printed patches, Skin permeability, First-pass metabolism, Smart drug delivery systems.

2:- INTRODUCTION

2.1 : Introduction and classification of Patches

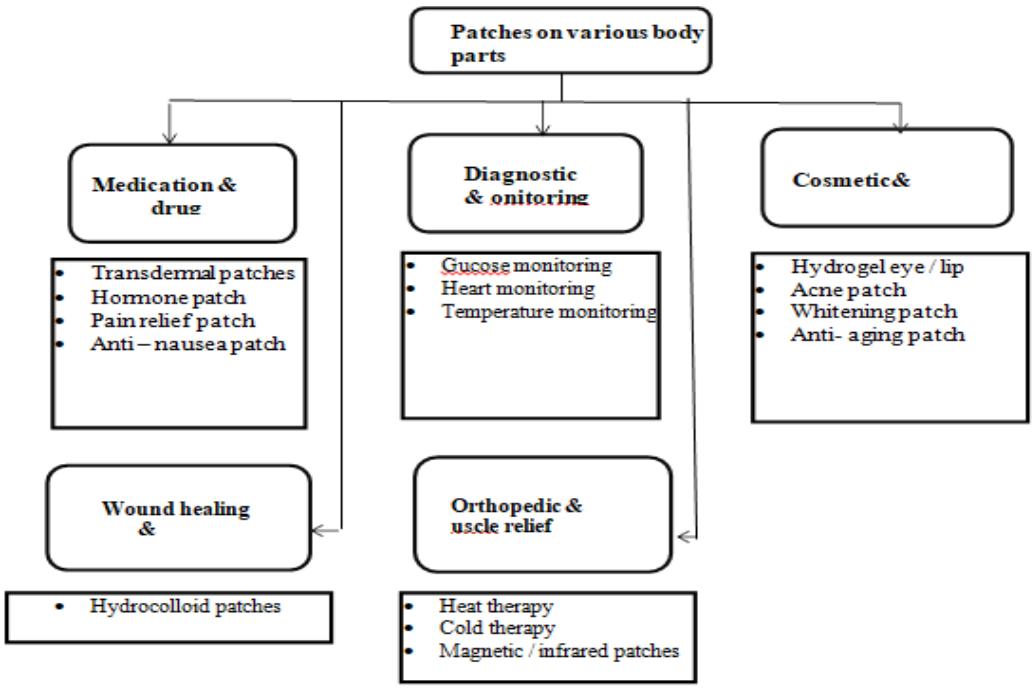
Transdermal drug delivery offers an alternative route of administering medicines by allowing drugs to pass through the skin and enter the bloodstream. Once absorbed, the drug circulates

throughout the body before reaching its target site. This method has several benefits compared to traditional routes of administration. For instance, it can provide a steady release of medication over an extended period, avoid the digestive system, and bypass first-pass metabolism in the liver. In contrast, intravenous injections may cause discomfort and carry a risk of infection, while oral medicines can be less efficient and inhalation therapy often makes precise dose control difficult. Because of these advantages, transdermal delivery is commonly used for conditions like smoking cessation, chronic pain, motion sickness, and hormone replacement therapy.[1,28]

A transdermal drug delivery patch is a simple, non-invasive system designed to transport therapeutic agents across the skin barrier and release them into the bloodstream at a controlled and sustained rate. Patches are non-invasive, easy to use, and can work for several days, with the added convenience of stopping treatment at any time by simply removing the patch. They come in different sizes and may contain single or multiple active ingredients.[1,29]

The nitroglycerin patch, developed by Gale and Berggren, which used an ethylene vinyl acetate membrane to control the release rate. Since then, many drugs have become available in patch form, including estradiol, clonidine, fentanyl, nicotine, scopolamine and estradiol combined with norethisterone acetate.[1]

2.2 CLASSIFICATION



3 TYPES OF PATCHES

3.1 MEDICATION AND DRUG DELIVERY

3.1.1 Transdermal Patch

A transdermal patch is a medicated adhesive dosage form placed on the skin to deliver a specific dose of medication into the bloodstream to achieve a systemic effect. This system, known as transdermal drug delivery system(TDDS), transport the drug through the skin's viable epidermal and dermal tissues, with a major fraction entering the systemic circulation. Transdermal therapeutic systems are specifically designed to provide a controlled and continuous delivery of drugs. This route of administration is beneficial because it overcomes issues associated with other drug delivery methods.[3]

Types of transdermal patches

1. Asymmetric TPX membrane Method
2. Circular Teflon Mould Method
3. IPM membranes Method

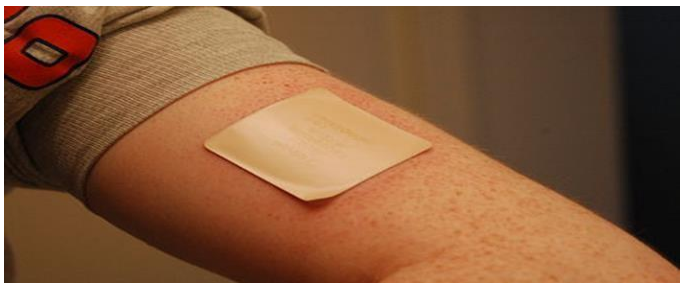


Fig no .1:- Transdermal patches.[3]

Method of preparation of transdermal patches

1. Asymmetric TPX Membrane Method
Uses poly(4-methyl-1-pentene) membranes prepared by dry/wet inversion for controlled release.

↓

2:- Circular Teflon Mould Method
Drug and polymer dissolved in solvent, poured into a Teflon mould, solvent evaporated, and film dried.

↓

5. Aluminium Backed Adhesive Film Method
Drug dissolved in chloroform with adhesive, cast on aluminium foil.

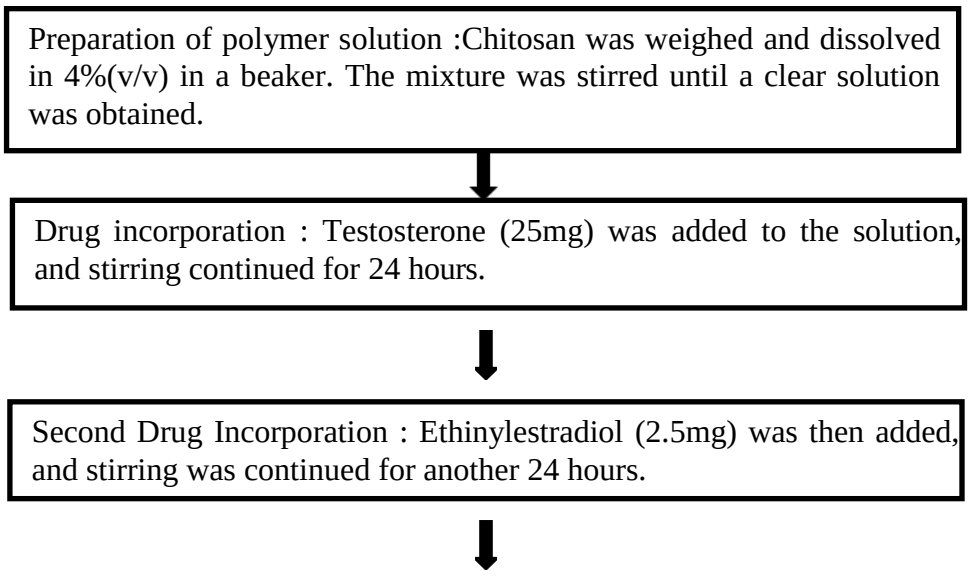
Advantages And Disadvantages[3]

Advantages	Disadvantages
1. Metabolism Bypass: Avoids first-pass hepatic, salivary, and intestinal metabolism.	1. Skin Issues: High possibility of skin irritation due to formulation components.
2. Easy Administration: Enables patient self-Administration and offers a non-invasive, painless route.	2. Dosing Limits: Suitable only for drugs with high potency.
3. Controlled Release: Provides continuous, non invasive drug infusion, ideal for drugs with short half-lives.	3. Drug Type Restriction: Not feasible for ionic or large-molecule drugs.
4. GI Protection: Suitable for drugs that cause gastrointestinal irritation or have poor oral absorption.	4. Dose Dumping Risk: Drug binding to the skin may lead to uncontrolled release (dose dumping).

3.1.2 HORMONE PATCHES

Hormone patches are transdermal drug delivery devices that continuously release hormones into the bloodstream through the skin. It is frequently used in contraception and hormone replacement treatment. By avoiding first- pass liver metabolism, the patch keeps hormone levels constant, increasing efficacy and lowering adverse effects. To deliver testosterone and ethinylestradiol together through the skin, a matrix-type Transdermal Drug Delivery System (TDDS) called an e-patch was created. Primary goal: For postmenopausal women receiving oestrogen replacement therapy (ERT), the combination therapy is designed. Target of Therapy: It helps postmenopausal women with Hypoactive Sexual Desire Disorder (HSDD) have more libido and sexual arousal. Reasons for Combination: The only way to increase serum hormone-binding globulin (SHBG) is through oestrogen replacement therapy (ERT).[5]

Method Of Preparation Hormone Patches[6]



Casting And Drying: The final solution was poured onto a Teflon-coated mould (area).The mould was covered with an inverted funnel to control the solvent evaporation rate, and the film was left undisturbed to dry overnight.

↓

Storage: The dried film is cut into patches of required size, then stored in desiccators until use.

Advantages and Disadvantages[6]

Advantages	Disadvantages
1. Bypassing of hepatic first-pass metabolism.	1. Transdermal delivery is limited to drugs with low doses, low melting points, and molecular weights, and requiring solubility greater than 1 mg/mL in both water and mineral oil.
2. Maintenance of steady plasma or serum levels of the drug.	2. Estrogen Replacement Therapy (ERT) increases Serum Hormone Binding Globulin (SHBG) production.
3. Enhancement of therapeutic efficiency.	3. Increased SHBG may reduce available free testosterone in postmenopausal women treated with exogenous estrogen compared to untreated women.
4. Prolonged duration of action for potent drugs with short plasma half-life.	4. Reduced free testosterone may lead to decreased sexual function in women undergoing ERT.

3.1.3 PAIN RELIEF PATCHES

A transdermal patch is a treated tenacious patch that's placed on the skin to deliver a specific dose of medicine through the skin and into the bloodstream. common pain is one of the current ailments. The disquisition was carried out by fabricating of transdermal common relief patch, which is a treated tenacious patch. This patch is intended to be a revolutionary medicine delivery system.[8]

Fig no 3:- pain relief patch.[7]

Method Of Preparation[8]

API Preparation: Camphor was mixed with mustard oil, followed by 2–3 drops of clove oil, and dissolved in ethanol.

↓

Drug Matrix Preparation: HPMC and EC were dissolved in methanol. PEG 400 was added and stirred to form a uniform solution.

↓

Casting & Drying: The mixture was cast on a PVA backing membrane and dried at room temperature for 24 hours.

↓

Finishing & Storage: Dried films were peeled off, wrapped in aluminum foil, and stored in a desiccator until use.

ADVANTAGES & DISADVANTAGES[8]

Advantages of Patches	Disadvantages of Patches
1. It is a water-resistant.	1. The solution of the compounds leads to greasiness, causing, inconvenience and limiting travel.
2. It provides pain and inflammation relief.	2. The oil sticks to the hands, making it uncomfortable to use.
3. Provides 12 hours of continuous relief.	3. Causes inconvenience in daily life routine.
4. The patch can be applied at any time and in any location.	4. May cause mild skin irritation or allergy in sensitive individuals.

3.1.4 Anti-nausea Patches

The Transdermal Drug Delivery System (TDDS) is one of the new routes for systemic delivery of medicines through the skin. A transdermal patch (TP) is a treated patch that's placed on skin for the delivery of drug through the skin into the bloodstream. Vomiting/ emesis (qai) is an abnormal suggestion of the gastrointestinal tract, and the oral route of drug administration is generally not suited. The end of the present study was to formulate and estimate a Unani transdermal patch that could be used for an antiemetic remedy.[9]

Method of Preparation[9]

1. **Extracting the Oils:** The active oils were gently extracted from Khardal seeds, Zanjabeel rhizomes, and Podina leaves using a Clevenger apparatus, keeping the temperature between 50–70 °C.

↓

2. Making the Emulsion: The oil mixture (75% Khardal oil and 25% Zanjabeel-Podina oils) was combined with a 5% vinegar solution as the water phase. Tween 80 and ethanol were added to stabilize the emulsion, and the most stable mixture was chosen for the patch.

⬇

3. Preparing the Patch: A 4% lactic acid solution in water and ethanol (1:1) was warmed to 37 °C. Chitosan (125 mg) was slowly stirred in until fully dissolved, then PEG-400 and water were added for a uniform mixture. The optimized emulsion was incorporated drop by drop, stirred, and poured into a 4×2 cm^2 mold. After drying overnight, the film was cut into two convenient 2×2 cm^2 patches.

Advantages & Disadvantages[45]

Advantages	Disadvantages
1. Give long lasting relief.	1. Works at slow rate.
2. Easy to use and convenient than pills.	2. It can cause skin irritation.

3.2 DIAGNOSTIC AND MONITORING PATCHES

3.2.1 Glucose monitoring

Glucose monitoring patches are wearable devices enabling real-time, painless glucose tracking. The described microneedle patch uses a reversible FRET-based hydrogel sensor for continuous glucose monitoring (CGM)**.** It measures glucose in the interstitial fluid (ISF) with high accuracy, offering a minimally invasive, flexible, and reliable alternative to traditional CGM systems.[10]

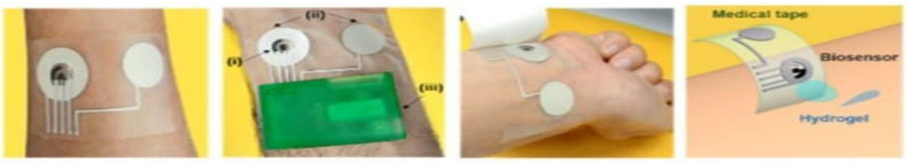


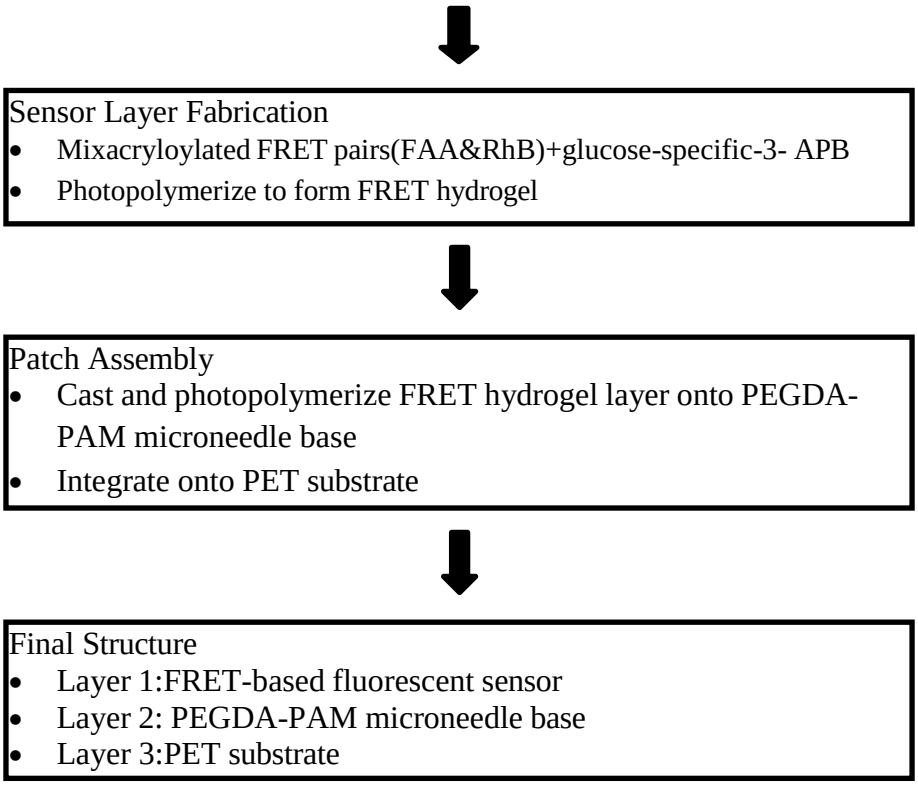
Fig. no:- 4 glucose monitoring patches.[10]

Method of preparation[11]

- Hydrophobic PET Substrate (Base Support)
- (Base Sensor Layer Fabrication

⬇

Microneedle Base Fabrication
- Prepare PEGDA–PAM prepolymer solution
- Fill PDMS microneedle mold
- Photopolymerize to form hydrogel base



ADVANTAGES AND DISADVANTAGES[12]

Category	Advantages	Disadvantages
Design	The microneedle patch is minimally invasive, painless, and flexible. It avoids contact with blood vessels and nerves, making it comfortable for users.	The device responds slowly, taking about 22–25 minutes to stabilize after a change in glucose levels.
Performance	It provides accurate and continuous monitoring of glucose levels in interstitial fluid (ISF).	Sensitivity decreases at high glucose concentrations because of fewer boronate sites and reduced elasticity of the hydrogel.

3.2.2 HEART MONITORING PATCHES

Long-term monitoring for cardiac rhythm abnormalities, like atrial fibrillation (AF), aims to improve diagnostic yield. While the 12-lead Holter monitor is the "gold standard," its relatively low diagnostic yield, cost, and inconvenience have driven the development of ultra-portable ECG patch monitors (EPMs). These devices, which underwent radical miniaturization and redesign to be attached directly to the skin via a patch carrier, are designed for very long-term monitoring in real-world environments like the home or workplace. EPMs hold promise for various cardiac monitoring applications.[12]

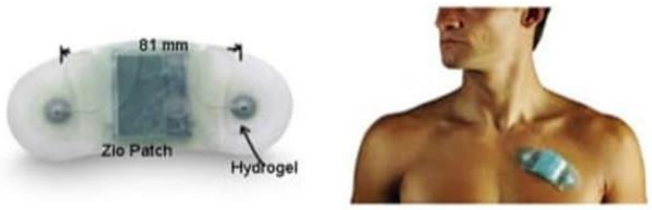


Fig no 5:- heart monitoring patch.[12]

Method of Preparation[12]

EPM divided into: ECG Processing + Wireless Transmission

↓

ECG Processing (SoC)
(AFE acquires → Amplify & Filter → 12-bit ADC digitizes → DSP analyzes)

↓

Motion artifacts reduced using accelerometer data

↓

Wireless Transmission (BLE SoC)
(Data sent via SPI to BLE → Transmitted to smartphone)

↓

Patient Interface
(Adhesive patch with wet gel electrodes, ~80 mm apart)

↓

Powered by Li-Po battery

Advantages and disadvantages[12]

Advantages	Disadvantages
1. Ultra-portable and comfortable: The device is small, wireless, and easy to wear, which greatly enhances patient comfort and makes it more convenient for everyday use.	1. Limited technology integration: It doesn't yet combine all features of a Holter monitor, event recorder, and real-time monitoring system.
2. Longer monitoring period: Can record ECG data continuously for up to 14 days, allowing better tracking of heart rhythms over time.	2. Data and durability limitations: Records only a single ECG channel, and the adhesive patch may lose stickiness with prolonged use.

3.2.3 Temperature Monitoring Patches

Body temperature is a vital sign for monitoring health, but traditional methods (like oral or rectal thermometers) are often intermittent, invasive, and unsuitable for continuous, long-term monitoring in daily life. Recently, wearable devices and epidermal electronic devices (EEDs), such as smart patches, have emerged to address this by offering thin, flexible, and continuous temperature monitoring. While the technical performance of these smart patches has been demonstrated in lab settings, their reliability, validity, and practical use in real-world, daily life environments remain poorly studied.[23]

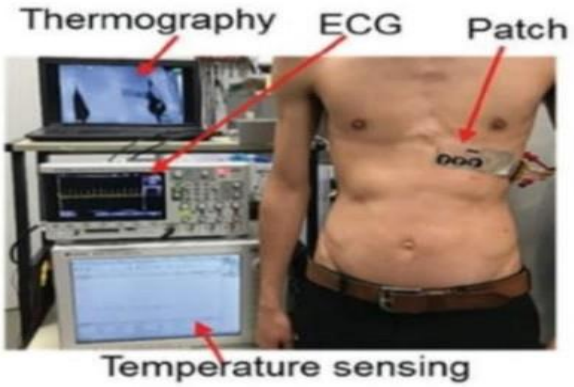
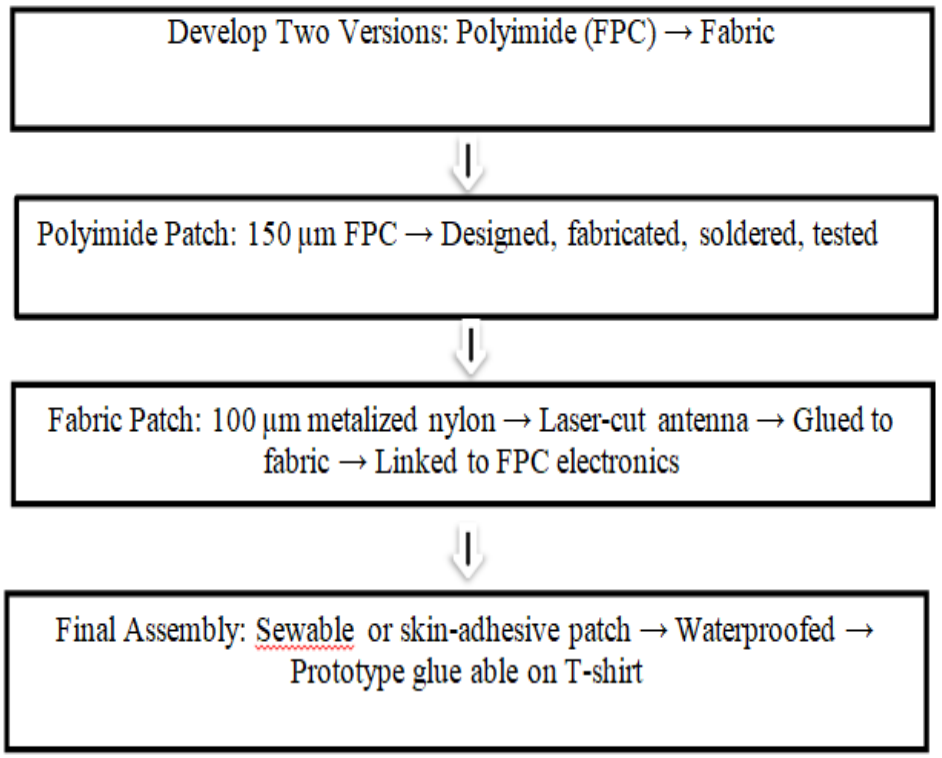


Fig. no 6:- temperature monitoring patches.[13]

Method of Preparation[14]



Advantages and disadvantages[14]

Advantages	Disadvantages
1. Wearable and flexible: The bendable, fabric-based design enhances comfort and makes the device more user-friendly.	1. Requires waterproofing: Needs additional protective layers for safe and effective skin-contact use.
2. Comfortable design: Covers only a small skin area and can be conveniently sewn into clothing for daily wear.	2. Further development needed: The device design and fabrication methods still need improvement to enhance performance and durability.

3.3 COSMETIC PATCHES

3.3.1 Hydrogel eye patches

This poly-herbal hydrogel patch is specially formulated to target common under-eye concerns like dark circles, puffiness, and dryness. It combines the natural benefits of four key ingredients:

- Rubia cordifolia (Manjishtha): Known for its skin-brightening and antioxidant properties.
- Green Tea (Camellia sinensis): Helps reduce puffiness and supports depigmentation.
- Honey: Deeply moisturizes and soothes the skin.

Together, these ingredients work to brighten the under-eye area, reduce inflammation and itching, and leave the skin feeling smooth, nourished, and refreshed.[16,34]

Fig no. 7:- hydrogel eye patch.[16]

Method of Preparation[16,35]

Herbal Extract Preparation:
Extracts of *Tabernaemontana divaricata* and *Rubia cordifolia* are obtained using the Soxhlet extraction method, while green tea (*Camellia sinensis*) extract is prepared using the decoction (hot water extraction) method.

↓

Formation of Extract Mixture:
The concentrated herbal extracts are then mixed with honey (for moisturization), glycerine (as a humectant and plasticizer), and methyl paraben (as a preservative) to create a uniform extract mixture.

↓

Preparation of Polymer Solution:
Water is boiled to 90 °C, and agar powder is slowly added with continuous stirring until it fully dissolves, forming a clear polymer solution.

↓

Mixing Phase:
The prepared extract mixture is added to the hot polymer solution and stirred continuously for 2 minutes to ensure uniform blending.

↓

Molding and Setting:
The final mixture is poured into eye patch molds and allowed to cool at room temperature for about 5 minutes, enabling the hydrogel to set and solidify.

↓

Demolding and Final Touches:
Once solidified, the patches are carefully demolded, and a serum is applied between each patch. The finished hydrogel patches are then stored in a well-closed container to maintain their quality and efficacy

Advantages and disadvantages[16,36]

Advantages	Disadvantages
1. Safer formulation	1. Water loss (Trans-epidermal water loss may increase)
2. Multiple therapeutic effects	2. Incomplete clinical evaluation
3. Anti-inflammatory effects	3. Further studies needed for long-term safety
4. Contain antioxidant properties	4. Limited penetration of active ingredients

3.3.2 ACNE PATCH

Acne patches are a new invention for topical acne treatment that are in great demand due to their ability to conceal and treat acne at the same time. They are also easier to buy, to use, and to carry on, making them very popular among consumers. In general, the acne patches already on the market contain hydrocolloid synthesizing substances, and are usually made of hydrocolloids or hydrogels, substances known for their use in medical dressings. Based on the type of acne, acne patches are divided into microneedle patches, medicated acne patches (hydrogel patches), and hydrocolloid patches (non-medicated).[17,36.37]

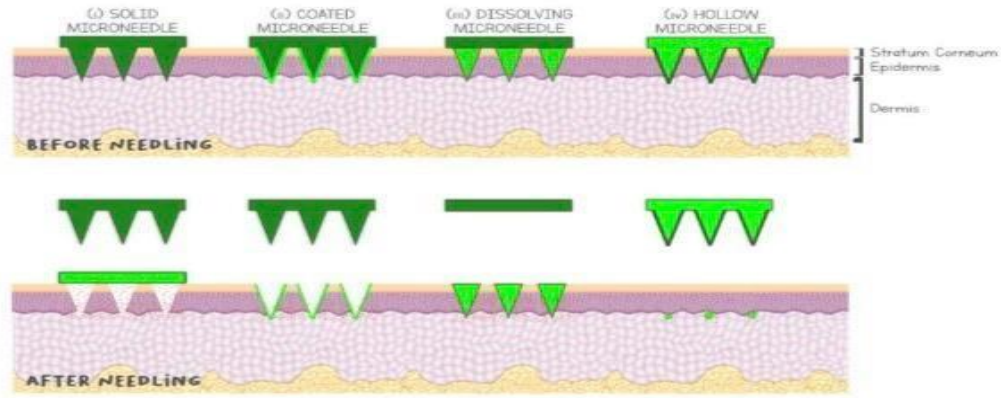


Fig no 8:- Illustration of a microneedle on the skin.[16]

Method of Preparation[17,38]

Select type – Dissolving or Hollow MN [microneedle]

↓

For dissolving MN – use biodegradable materials (silk fibroin, hyaluronic acid)

↓

Encapsulate drug in polymer mixture

↓

Pour mixture into molds and solidify

↓

For hollow MN – use metals or fused silica

↓

Apply metal coating (if needed)

↓

Form hollow structures for liquid delivery

↓

Demold and assemble patches

↓

Store in sterile, sealed containers

Advantages and disadvantages[16]

Advantages	Disadvantages
1) Generally safe to use	1) May cause slight moisture loss from the skin
2) Offers more than one skin benefit at a time	2) Not fully tested in all conditions
3) Helps reduce redness and irritation	3) More research is still needed for long-term use
4) Rich in antioxidants that protect the skin	4) May not absorb deeply enough for strong results

3.3.3 Whitening Patches

Whitening patches offer an effective way to deliver skin-brightening agents through the skin. Reduced glutathione (GSH) is a key ingredient known for its antioxidant and tyrosinase-inhibiting properties, which help reduce melanin formation. However, its use is limited by poor skin permeability and an unpleasant odor. To address this, a dissolving microneedle (MN) patch made with hyaluronic acid (HA) has been developed, enhancing GSH absorption and reducing odor for a more effective and user-friendly skin-whitening treatment.[18]

Fig no 9:- Microneedle patches for skin whitening.[18]

Method of Preparation (Fabrication of GSH-MN Patches).[18]

Start by preparing a reusable polydimethylsiloxane (PDMS) mold with bullet-shaped microneedle arrays at a density of 10 × 10 MNs per cm^2.

↓

Replicate the negative PDMS mold from a metal microneedle array to form the mold structure

↓

Prepare an aqueous solution containing 10% hyaluronic acid (HA) mixed with varying concentrations of glutathione (GSH) at 0%, 1.0%, 2.5%, and 5.0% by weight.

↓

Pipette the microneedle-forming solution into the PDMS molds carefully.

↓

Degas the filled molds under vacuum to eliminate any air bubbles trapped inside.

↓

Dry the molds at 40 °C for 12 hours to allow solvent casting and solidification of the microneedles.

↓

Finally, demold the solidified patches to collect the fabricated GSH-MN patches

Advantages and disadvantages[18]

Advantages	Disadvantages
1) Microneedle technology allows better absorption of glutathione (GSH) through the skin	1) GSH normally has poor skin penetration and a strong unpleasant odor.
2) Hyaluronic acid (HA) used in the patch helps mask the bad smell of GSH.	2) Traditional topical creams struggle to deliver GSH past the skin's outer layer (stratum corneum).

3.3.4 Antiaging Patches

Skin wrinkles are visible creases or folds resulting from intrinsic or extrinsic aging. Extrinsic aging is primarily caused by Ultraviolet rays (UVRs), which lead to free radical generation. Plant stem cells are used in cosmeceuticals as anti-wrinkle agents to enhance the elasticity of the epidermis.

Method of Preparation[19]

Rosmarinic Acid (RA) Extraction:
Salvia miltiorrhiza (SM) calli were cultured from shoot tip explants on MS [Murashige and Skoog medium].

↓

The cells were harvested, freeze-dried, and then subjected to Ultrasonic- Assisted Extraction using 75% aqueous methanol.

↓

Elicitation Treatment:
Calli were treated with Jasmonic acid (JA) or Salicylic acid (SA) to Increase RA levels. The JA concentration of 50 μM yielded the highest RA content (16 mg/g).

↓

Electrospinning of Nanofiber Patch (Simplified Version):
Polyurethane was dissolved in a dimethyl formamide and acetone mixture (1:1). The RA extract (1 mg/mL) was blended with the polymer and spun into nanofibers using a coaxial electrospinning setup. A 10 cm gap between the needle and collector and a voltage of 25 kV were used to form a smooth and uniform patch.

Advantages & Disadvantages[19]

Advantages	Disadvantages
1) Reduces wrinkles and softens skin in UV- induced mouse models	1) Preparation is complex, requiring careful optimization of elicitors (e.g., JA at 50 μM)
2) Nanofiber structure enhances deep skin penetration	2) Limited clinical data; more human studies are needed

3.4 WOUND HEALING AND PROTECTING

3.4.1 Hydrocolloid Patches

Hydrocolloid patches (or dressings) are a type of advanced wound care material engineered to promote a moist healing environment. This environment is crucial for autolytic debridement and granulation tissue formation, leading to faster healing with reduced scarring.[42]

Method of Preparation[42]

Base Polymers(Elastomers) Tackifiers (Mix & Heat at 100 – 160 °C)

↓

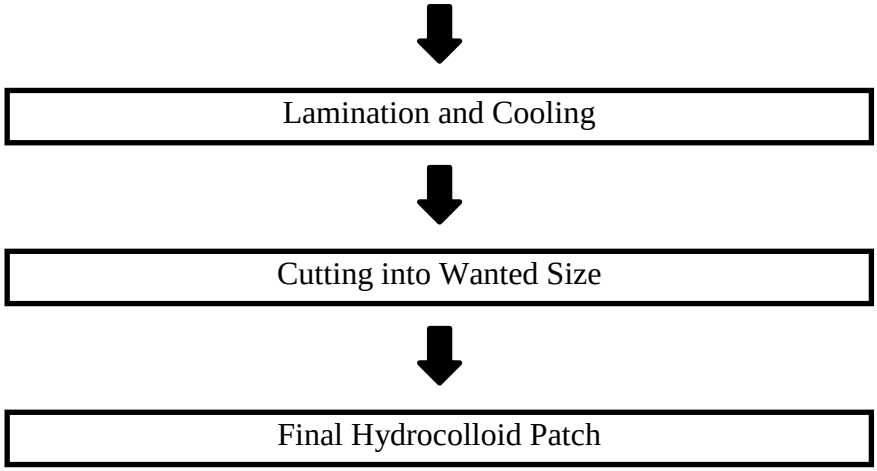
Cohesive Molten Mass Formed

↓

Homogeneous glue- Hydrocolloid mix

↓

Coating on Release Liner/ Carrier Film



Advantages and Disadvantages[43]

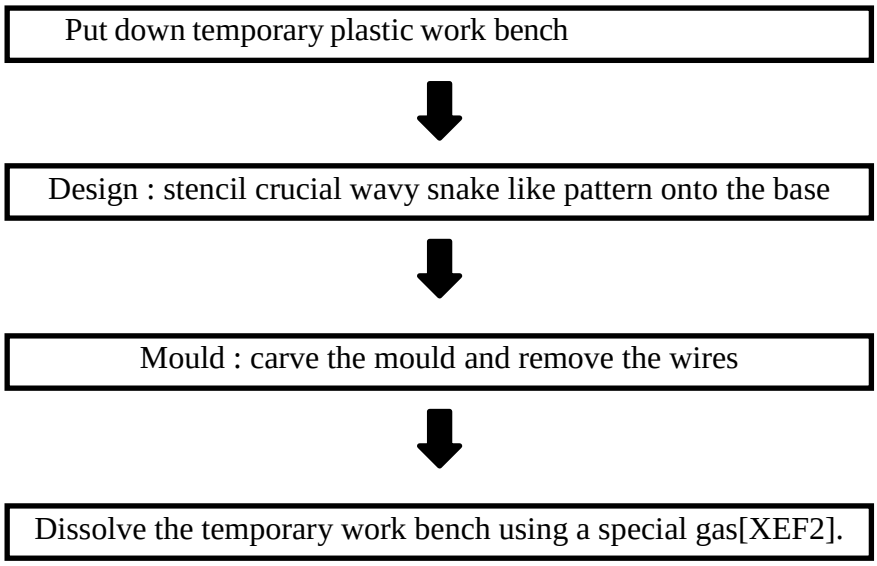
Advantages	Disadvantages
1. Promotes faster healing.	1. Can cause irritation and allergy.
2. Protects wound from dirt, bacteria etc.	2. Not suitable for infected wounds.
3. Works well for acute wounds.	3. Limited effectiveness.
4. Pain and itching can be reduced using this patch.	4. Removal can damage or irritate skin.

3.5 ORTHOPEDIC AND MUSCLE RELIEF

3.5.1 Heat Therapy Patches

Heat therapy is a simple, cheap, and drug-free way to relieve pain with few side effects. It works by using the gate control theory, which says that heat turns on skin receptors that stop pain signals from getting to the brain. Heat also makes blood flow better (vasodilation), relaxes muscles, stops spasms, and feels good. The best temperature for superficial heat therapy is between 40 and 45 degrees Celsius.[20]

Method of Preparation[20]



Advantages and disadvantages[20]

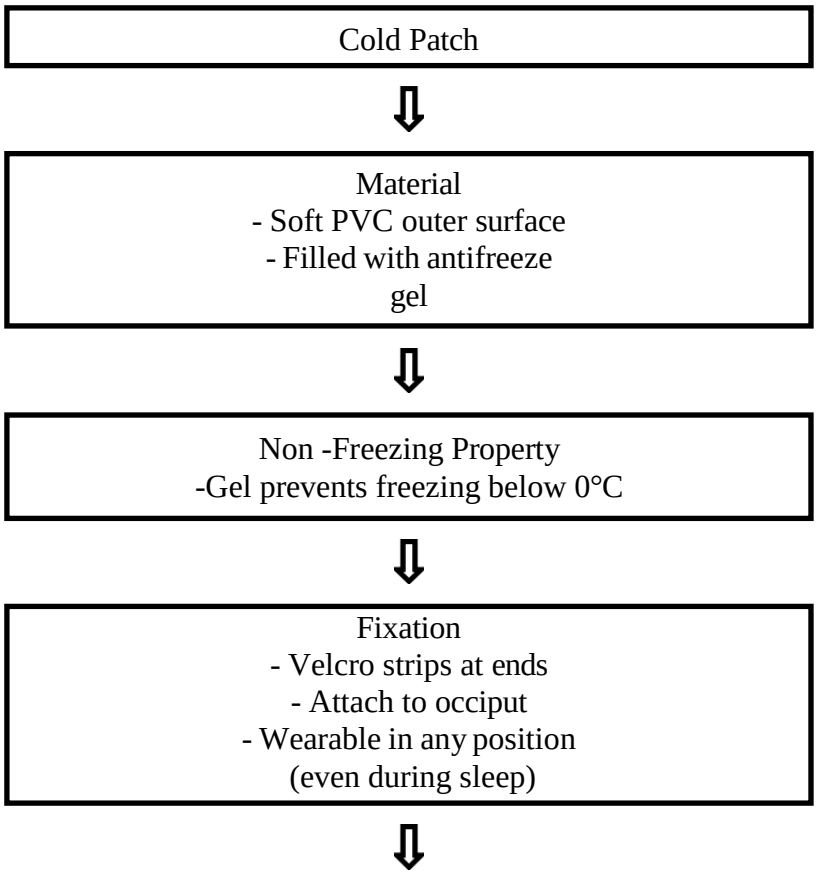
Advantages	Disadvantages
1. Stretchable and fits on any body part	1. Restricted heat range only
2. Adjust temperature via smartphones for precise control.	2. Can cause irritation and rashes.

3.5.2 COLD THERAPY PATCHES

Cold therapy, also known as cryotherapy, is the practice of putting cold on the body to ease symptoms and speed up healing. It is often used in sports medicine and rehab, especially right after an injury. Cooling the affected area helps slow down inflammation by narrowing blood vessels, reduces muscle spasms, and numbs the tissues to relieve pain.[44]

Fig. no 10:- cold therapy patch.[21]

Method of Cold Patch Preparation[21,26]



Application Protocol
- Cool to 5–8°C before use
Wear 30 min → Re-cool 30
- Repeat cycle continuously
for 24 hrs post-surgery
- Continue until sleep

Advantages & disadvantages[21,25]

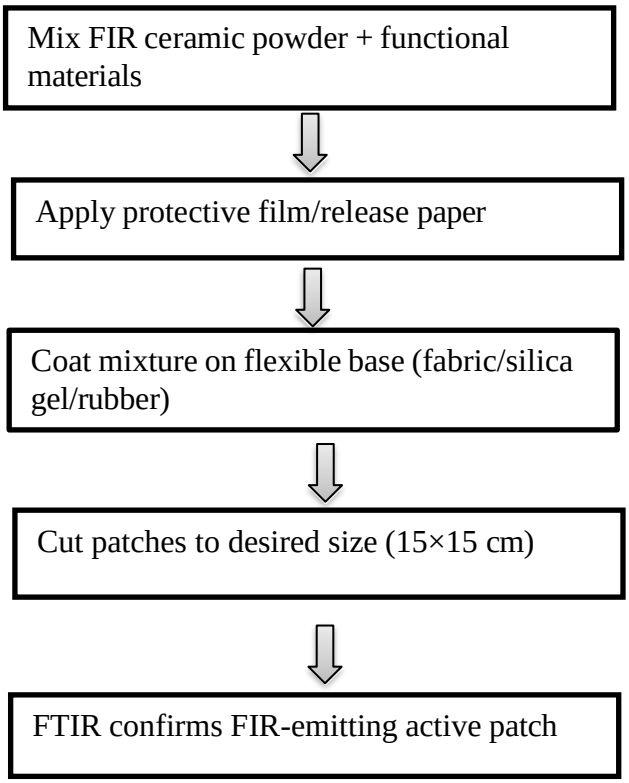
Advantages of the Cold Patch	Disadvantages of the Cold Patch
1 Effective Pain Relief – Significantly lowers pain at 8h, 16h, and 24h post- surgery. – Works through local cooling that reduces nerve activity (similar to anesthesia).	1. Requires Regular Re-Cooling Needs refrigeration every 30 minutes.
2. Reduces Inflammation & Swelling – Decreases eyelid edema and redness. – Cooling causes vasoconstriction and limitsinflammation.	2. Short Cooling Duration – Effectlasts only while worn.

i. Magnetic/Infrared Patches

Far-infrared radiation (FIR) therapy is gaining attention as a non-invasive approach to easing musculoskeletal pain and improving blood circulation. Infrared light is classified into three categories based on wavelength: near- infrared (0.8–1.5 μm), mid-infrared (1.5–5.6 μm), and far-infrared (5.6–1000 μm). FIR is capable of penetrating the skin and has been shown to enhance blood flow to peripheral tissues, support microcirculation, and promote tissue repair. Both clinical and experimental studies report that FIR therapy can increase skin blood flow and accelerate wound healing, making it useful for pain relief and muscle recovery. FIR patches are convenient because they are thin, discreet, easy to apply, and generally considered safe, even for individuals with limited mobility.[41]

Fig. no 11:- Far-Infrared Patches.[22]

Method of Preparation for Far-Infrared Patches[22]



Advantages & disadvantages[41]

Advantages	Disadvantages
1. It is painless and non-invasive technique.	1. Effect is limited to specific skin layer.
2. It is easy to apply and user friendly.	2. It gives only short-term effect.

REFRENCES

1. Wong WF, Ang KP, Sethi G, Looi CY. Recent advancement of medical patch for transdermal drug delivery. Medicina (Kaunas). 2023; 59(4): 778. doi:10.3390/medicina59040778.
2. A brief overview on transdermal patches and marketed preparations. Int J Health Clin Res [Internet]. 2025 [cited 2025 Oct 10]. Available from: https://ijhcr.com/index.php/ijhcr/article/view/5449/3541
3. T. Transdermal patches: A review [Internet]. 2024 [cited 2025 Oct 18]. Available from: https://share.google/meeMWUb3q9yBDQWid
4. Alam MI, Alam N, Ali MS, Anwer T. Type, preparation and evaluation of transdermal patch: A review. World J Pharm Pharm Sci., 2013; 2(2): 2199–233.
5. Lawrentschuk N, Fleshner N. Severe irritant contact dermatitis causing skin ulceration secondary to a testosterone patch. Sci World J., 2009; 9: 333–8. doi:10.1100/tsw.2009.45.
6. Baghel Chauhan S, Naved T, Parvez N. Formulation and evaluation of …. Int J Appl

Pharm., 2019; 11(1): 55. doi:10.22159/ijap.2019v11i1.28564.

7. Gudin JA, Dietze DT, Hurwitz PL. Using nanotechnology to improve pain and function with a novel, drug- free, topical pain-relief patch: An interim analysis. Anesth Pain Res., 2020; 4(3). doi:10.33425/2639- 846x.1047.
8. Maskare RG, Wadhwani MV, Asati GG, Mane VA, Dahake ST, Banothe SK. Fabrication of an herbal patch for fast guard joint pain relief. Res J Top Cosmet Sci., 2024; 27–32.
9. Saleem MN, Idris M. Formulation design and development of a Unani transdermal patch for antiemetic therapy and its pharmaceutical evaluation. Scientifica. 2016; 2016: 1–5.
10. De la Paz E, Barfidokht A, Rios S, Brown C, Chao E, Wang J. Extended noninvasive glucose monitoring in the interstitial fluid using an epidermal biosensing patch. Anal Chem., 2021; 93(37): 12767–75. doi:10.1021/acs.analchem.1c02887.
11. Hu Y, Pan Z, De Bock M, Tan TX, Wang Y, Shi Y, et al. A wearable microneedle patch incorporating reversible FRET-based hydrogel sensors for continuous glucose monitoring. Biosens Bioelectron, 2024; 262: 116542. doi:10.1016/j.bios.2024.116542.
12. Lobodzinski SS. ECG patch monitors for assessment of cardiac rhythm abnormalities. Prog Cardiovasc Dis., 2013; 56(2): 224–9. doi:10.1016/j.pcad.2013.08.006.
13. Yamamoto Y, Yamamoto D, Takada M, Naito H, Arie T, Akita S, et al. Efficient skin temperature sensor and stable gel-less sticky ECG sensor for a wearable flexible healthcare patch. Adv Healthc Mater., 2017; 6(17): 1700495. doi:10.1002/adhm.201700495.
14. Wen S, Heidari H, Vilouras A, Dahiya R. A wearable fabric-based RFID skin temperature monitoring patch.
15. Enlighten: Publications (University of Glasgow). 2016. doi:10.1109/icsens.2016.7808919.
16. Mahdavi H, Kermani Z, Faghihi G, Asilian A, Hamishehkar H, Jamshidi A. Preparation and evaluation of cosmetic patches containing lactic and glycolic acids. Indian J Dermatol Venereol Leprol. 2006; 72(6): 432. doi:10.4103/0378-6323.29339.
17. Riya ZS, Nair MS, Abhirami JR, Abhirami JP, Ramesh NK. Formulation and evaluation of herbal hydrogel under-eye patch. World J Pharm Res., 2025; 14(5): 779–98. doi:10.20959/wjpr20255-35701.
18. Qothrunnadaa T, Hasanah AN. Patches for acne treatment: An update on the formulation and stability test. Int J Appl Pharm., 2021; 13(4): 21–6.
19. Lee Y, Kumar S, Kim SH, Seong KY, Lee H, Kim C, et al. Odorless glutathione microneedle patches for skin whitening. Pharmaceutics. 2020; 12(2): 100.
20. Abdelmonem R, Bakr A, Badawy I, Ibrahim A, Attia RT. Quality by design approach for

the formulation and evaluation of stem-cells derived rosmarinic acid-loaded nanofibers as an anti-wrinkle patch: In vitro and in vivo characterizations. Pharmaceutics. 2024; 16(12): 1598.

21. Hussain AM, Ernesto Byas Lizardo, Galo, Nassar JM, Muhammad Mustafa Hussain. Ultrastretchable and Flexible Copper Interconnect-Based Smart Patch for Adaptive Thermotherapy. Advanced Healthcare Materials. 2015 Apr 1; 4(5): 665–73.
22. Zeng Y, Li Y, Gao JH. Application of a cold patch for relieving pain after transepithelial photorefractive keratectomy. Pain Res Manag. 2015; 20(4): 195–8.
23. Lai YT, Chan HL, Lin SH, Lin CC, Li SY, Liu CK, et al. Far-infrared ray patches relieve pain and improve skin sensitivity in myofascial pain syndrome: A double-blind randomized controlled study. Complement Ther Med. 2017; 35: 127–32.
24. Kim H, Kim S, Lee M, Rhee Y, Lee S, Jeong YR, et al. Smart patch for skin temperature: Preliminary study to evaluate psychometrics and feasibility. Sensors. 2021; 21(5): 1855. doi:10.3390/s21051855.
25. Duffey RJ, Leaming D. US trends in refractive surgery: 2003 ISRS/AAO survey. J Refract Surg. 2005; 21: 87–91. doi:10.3928/1081-597X-20050101-16.
26. Ivarsen A, Hjortdal J. Seven-year changes in corneal power and aberrations after PRK or LASIK. Invest Ophthalmol Vis Sci. 2012; 53: 6011–6. doi:10.1167/iovs.12-10208.
27. Hodge C, Lawless M, Sutton G. Keratectasia following LASIK in a patient with uncomplicated PRK in the fellow eye. J Cataract Refract Surg. 2011; 37: 603–7. doi:10.1016/j.jcrs.2010.12.036.
28. Khoueir Z, Haddad NM, Saad A, Chelala E, Warrak E. Traumatic flap dislocation 10 years after LASIK: Case report and literature review. J Fr Ophtalmol. 2013; 36: 82–6. doi:10.1016/j.jfo.2012.03.004.
29. Chien YW, Liu JC. Transdermal drug delivery systems. J Biomater Appl. 1986; 1: 183–206. doi:10.1177/088532828600100205.
30. Lasagna L, Greenblatt DJ. More than skin deep: Transdermal drug-delivery systems. N Engl J Med. 1986; 314: 1638–9. doi:10.1056/NEJM198606193142510.
31. Spiros AF. Cosmetic patches. In: Barel A, Marc P, Maibach HI, editors. Handbook of Cosmetic Science and Technology. 3rd ed. New York: Marcel Dekker; 2001; 237–40.
32. Dimas DA, Dallas PP, Rekkas DM, Choulis NH. Effect of several factors on the mechanical properties of pressure-sensitive adhesives used in transdermal therapeutic systems. AAPS Pharm Sci Tech., 2000; 1: E16.
33. Quan D, Venkateshwaran S, Ebert CD. Transdermal delivery devices containing

polydiorganosiloxane polymers to regulate adhesive properties. US Patent, 6, 730, 318. 2004.

34. Malakar S, Lahiri K, Banerjee U, Mondal S, Sarangi S. Periorbital melanosis is an extension of pigmentary demarcation line-F on face. Indian J Dermatol Venereol Leprol, 2007; 73(5): 323–5.
35. Steiner D. Clínica Denise Steiner [Internet]. São Paulo (Brazil). [cited 2025 Oct 29]. Available from: www.denisesteiner.com.br/derma_estetica/olheiras2.htm
36. Costa A, Basile DVA, Medeiros VLS, Moisés AT, Ota SF, V CAJ. Peeling de gel de ácido tioglicólico 10%: opção segura e eficiente na pigmentação infraorbicular constitucional. Surg Cosmet Dermatol. 2010; 2(1): 29–35.
37. American Academy of Dermatology Association (AAD). Acne clinical guideline [Internet]. 2021 [cited 2021 Jun 3]. Available from: https://www.aad.org/member/clinical-quality/guidelines/acne
38. Zhang Y, Feng P, Yu J, Yang J, Zhao J, Wang J, et al. ROS-responsive microneedle patch for acne vulgaris treatment. Adv Ther. 2018; 1(3). doi:10.1002/adtp.201800035.
39. Li Y, Zhang H, Yang R, Laffitte Y, Schmill U, Hu W, et al. Fabrication of sharp silicon hollow microneedles by deep-reactive ion etching towards minimally invasive diagnostics. Microsyst Nanoeng. 2019; 5: 41. doi:10.1038/s41378-019-0077-y.
40. Forman HJ, Zhang H, Rinna A. Glutathione: Overview of its protective roles, measurement, and biosynthesis. Mol Aspects Med. 2009; 30: 1–12. doi:10.1016/j.mam.2008.08.006.
41. Hayes JD, McLellan LI. Glutathione and glutathione-dependent enzymes represent a co-ordinately regulated defence against oxidative stress. Free Radic Res. 1999; 31: 273–300. doi:10.1080/10715769900300851.
42. Lai YT, Chan HL, Lin SH, Lin CC, Li SY, Liu CK, et al. Far-infrared ray patches relieve pain and improve skin sensitivity in myofascial pain syndrome: A double-blind randomized controlled study. Complementary Therapies in Medicine [Internet]. 2017 Dec 1 [cited 2023 Jul 22]; 35: 127–32. https://www.sciencedirect.com/science/article/pii/S0965229917306441
43. De Paepe K, Wibaux A, Ward C, Rogiers V. Skin Efficacy and Biophysical Assessment of Glycerol-Containing Hydrocolloid Patches. Skin Pharmacology and Physiology. 2009; 22(5): 258–65.
44. Kaur D, Gupta A, Singh N, R. Dhakate S. Anti-emetic Drug Delivery For Cancer Patients Through Electrospun Composite Nanofibers Transdermal Patch: In Vitro Study.

Advanced Materials Letters. 2015 Jan 1; 6(1): 33–9.

45. Complementary Therapies in Nursing [Internet]. Google Books. 2022 [cited 2025 Nov 6]. Available from: https://books.google.com/books?hl=en&lr=&id=x150EAAAQBAJ&oi=fnd&pg=PA413&dq=+INTRODUCTION+OF+COLD+THERAPY+PATCHES&ots=WS7-w8O1t0&sig=B4BdjYRdeO3ltIgzWpX3vcaSXjw
46. Ferris FD, Kerr IG, Sone M, Marcuzzi M. Transdermal scopolamine use in the control of narcotic-induced nausea. Journal of Pain and Symptom Management. 1991 Aug 1; 6(6): 389–93.