Chapter

Transdermal Delivery of Drugs for Acute and Chronic Pain

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Abstract

Pain is universal, it contributes substantially to morbidity, mortality, and disability, and is a serious health problem. Acute pain usually lasts less than 7 days, but often lasts up to 30 days, and may recur periodically. Chronic pain, defined as lasting more than 3 months, affects approximately 50 million people and generates costs of $635 billion. The problems related to inadequate pain management are frequent and important, so much so that emphasis has been given to the effective delivery of drugs through the skin. This organ has been studied extensively over the last decade because it is easily accessible and would help to solve the problem. It is evident that there is a need to improve transdermal drug delivery (TDD) as it offers multiple advantages, they are noninvasive, can be self-administered, and provide prolonged release. This chapter recapitulates the history of transdermal drug delivery and focuses on addressing the inadequate management of acute and chronic pain.

Keywords: transdermal drug delivery; chronic pain, acute pain, skin

1. Introduction

The International Association for the Study of Pain (IASP) defines pain as "an unpleasant sensory emotional experience associated with actual or potential tissue damage." It is the most frequent symptom in the medical office, associated with innumerable diseases. Pain negatively affects the patient's quality of life because it is usually poorly tolerated and interferes with daily activities. The presence of pain indicates that something is not working well, the perception is subjective and with a great emotional component. The etiology of pain is not always an easy task and requires an accurate assessment to determine its origin [1, 2]. It is important to recognize that not all pain is the same, so we must distinguish and classify each type of pain. Pain is mainly classified according to its duration as chronic pain, whose commonly accepted definition is "that pain that persists beyond the normal healing time," persists to the original cause, and has more than 3 months of duration. On the other hand, we have acute pain, which is of recent onset and lasts less than 3 months. It is important to distinguish between these two types of pain because their pathophysiology is different, therefore, the treatment is different (**Figure 1**) [1, 3]. Common routes of drug

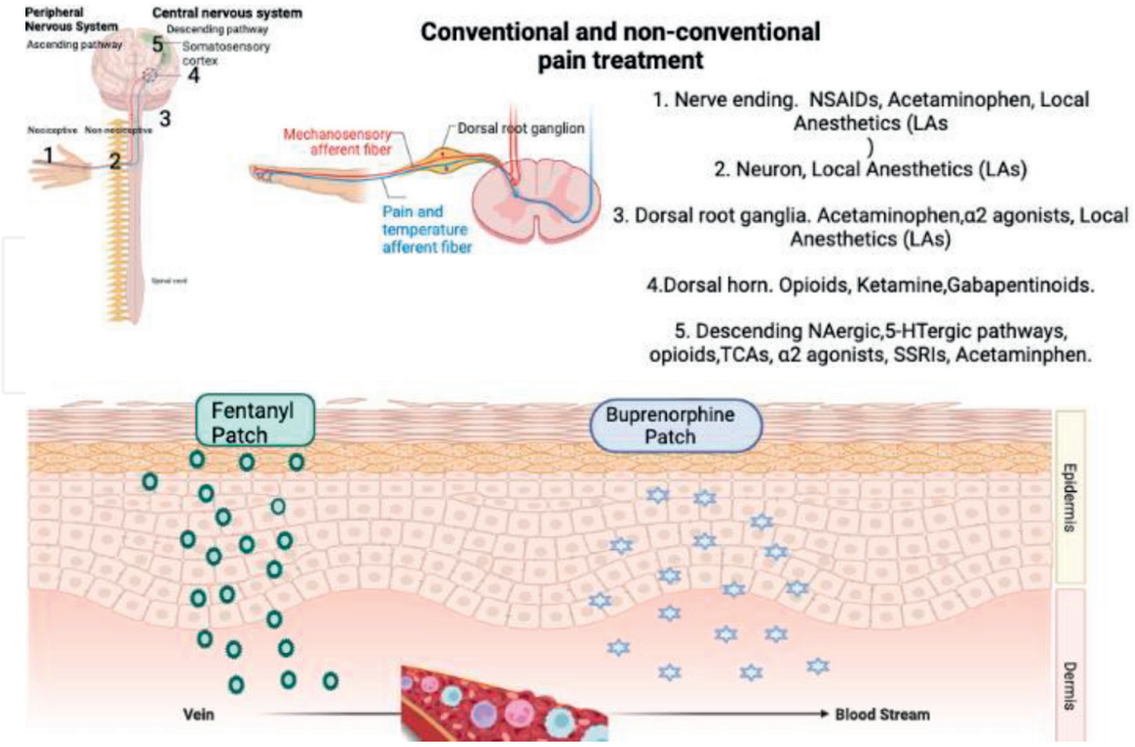

Figure 1.
Conventional and nonconventional pain treatment. The upper part of the figure shows the conventional treatment. The ascending pathway transmits pain and sensory information from the periphery to the brain. Painful stimuli activate primary afferent nociceptors of the mechanosensitive Aδ and C fibers, which send signals to second-order neurons in the spinal cord. This information is transmitted through the spinothalamic tract to tertiary neurons in the thalamus, and pain is perceived in the somatosensory cortex. The descending pathway inhibits pain via noradrenergic/serotonergic neurons and Aβ fibers. Conventional pain treatments and their sites of action (numbers) are shown. The lower part shows the nonconventional treatment, which consists of the application of transdermal patches to control pain. Abbreviation: NSAIDs: Nonsteroidal anti-inflammatory drugs; α2-agonists: α2-adrenergic receptor agonists; TCAs: Tricyclic antidepressants; SSRIs: Selective serotonin reuptake inhibitor.

administration are the oral and parenteral routes. However, their use is limited due to rapid degradation in the stomach. This is just one example as the conventional routes of drug administration could be overcome by using new technologies.

2. History (pain management)

In the 1970s, the first transdermal patches began to be developed, the first one approved being scopolamine, a treatment for motion sickness, which released the drug for 72 hours. Subsequently, nitroglycerin, clonidine, fentanyl, buprenorphine, lidocaine, nicotine, and hormone replacement therapy patches were approved for population management [4, 5].

3. Classification of drugs for acute and chronic pain

Pain is almost universal, and contributes substantially to morbidity, mortality, disability, and health system burden. Acute pain usually lasts less than 7 days, but often lasts up to 30 days, and may recur periodically. Although acute pain usually

Types of pain	Drug administration	Use of a strategy	Use of agents
Mild pain	Administration of paracetamol or NSAIDs	Cognitive-behavioral strategies (relaxation, distraction, etc.)	Physical agents (cold, heat, massage, etc.)
Moderate pain	Administration of low-dose or low-potency Opioids Combinations of paracetamol or NSAIDs with low doses or low-potency opioids	Cognitive-behavioral strategies (relaxation, distraction, etc.)	Physical agents (cold, heat, massage, etc.)
Severe pain	Strong opioid analgesics (intermittent or all day) Continuous infusions of opioid analgesics (e.g., PCA) Neural block (intermittent or continuous) Spinal anesthesia (e.g., epidural anesthesia, intermittent, or continued)	Combined strategies	Not applicable

Table 1.
Pain control options.

resolves quickly, in some cases it may persist until it becomes chronic. Chronic pain, defined as pain lasting more than 3 months, is a serious public health problem in the United States, affecting approximately 50 million people and generating costs of $635 billion. Chronic pain substantially affects physical and mental functioning, reducing productivity and quality of life [6–10].

The American Geriatrics Society Panel on Chronic Pain identified four basic pathophysiologic pain mechanisms that have important implications for choosing pain management strategies [11]. In choosing pain management strategies, it is necessary to adhere to various scales and in this regard, there are several pain measurement scales that help to classify and quantify the magnitude of pain complaints. The results of these scales are also useful for documenting and communicating pain experiences. And in correlation to these scales, the classification of drugs used to treat pain has been made (**Table 1**).

4. Limitations and adverse effects of conventional treatments

The problems related to inadequate pain management are frequent and important. Uncontrolled severe pain can have serious adverse effects on the physical, psychological, emotional, social, and spiritual condition of patients, which has repercussions on daily life activities and leads to economic, labor, and social losses that affect a significant proportion of the population. The functional disability caused by pain is a cause of suffering in patients, their families, and other people close to them. Currently, there are four general categories of analgesic agents frequently used for the most common types of pain: paracetamol, nonsteroidal anti-inflammatory drugs (NSAIDs), and opioids. And one more category such as gamma-aminobutyric acid analogs, gabapentin analogs, and anticonvulsants. However, all of them have adverse effects, Paracetamol has been shown to cause liver

damage [10, 11]. NSAIDs are associated with varying degrees of gastrointestinal (GI), cardiovascular, and renal adverse effects. Opioids can cause respiratory depression and cognitive and motor impairment; they can also cause dependence and addiction [12, 13].

5. Transdermal drug delivery systems

The effective delivery of drugs through the skin has been studied during the last decade since the skin is easily accessible. Most compounds are administered with a hypodermic needle, the main limitation of this is pain, needle phobia, and transmission of infectious diseases, so alternatives that circumvent these aspects are sought [14]. However, needles are required to penetrate the skin barrier. The main barrier to delivering a therapeutic agent is the outermost layer of the skin, the stratum corneum (SC). Because of the above, skin permeabilization methods have been developed that offer great advantages over other drug delivery systems [14]. It is evident that there is a need to improve transdermal drug delivery (TDD) as it offers multiple advantages since they are noninvasive and can be self-administered; in addition, it provides prolonged release, i.e., for long periods, and is generally inexpensive when it becomes commercially available. TDD is a painless systemic delivery method, drugs are administered through healthy and intact skin, the drug initially penetrates through the stratum corneum, then passes through the deeper epidermis and dermis without accumulation in the dermal area. When the drug reaches the dermal layer, it becomes available for systemic absorption through dermal microcirculation [14, 15].

First-generation transdermal delivery systems have continued to evolve to reach the clinical setting. They are used in the administration of small, lipophilic, and low-dose drugs. Second-generation delivery systems where we see a different design using chemical enhancers, non-cavitational ultrasound and iontophoresis have also resulted in clinical products. Third-generation delivery systems target the stratum corneum using tools such as microneedles, thermal ablation, microdermabrasion, electroporation, and cavitational ultrasound. Currently, TDDS with microneedle and thermal ablation technology has been developed and is progressing through clinical trials for the delivery of macromolecules, such as insulin and parathyroid hormone [16, 17].

6. Formulation

The basic components of a TDDS include polymer matrix, membrane, drug, penetration enhancers, pressure-sensitive adhesives (PSA), backing laminates, and release coating, the characteristics and examples are enounced in **Table 2**. In **Figure 2** we can observe the composition of each layer that compose different types of TDDS.

7. When to use them or not to use them?

7.1 Transdermal patches are used when

- The patient has intolerant side effects and is unable to take oral medication (dysphagia) and is requesting an alternative method of drug delivery.

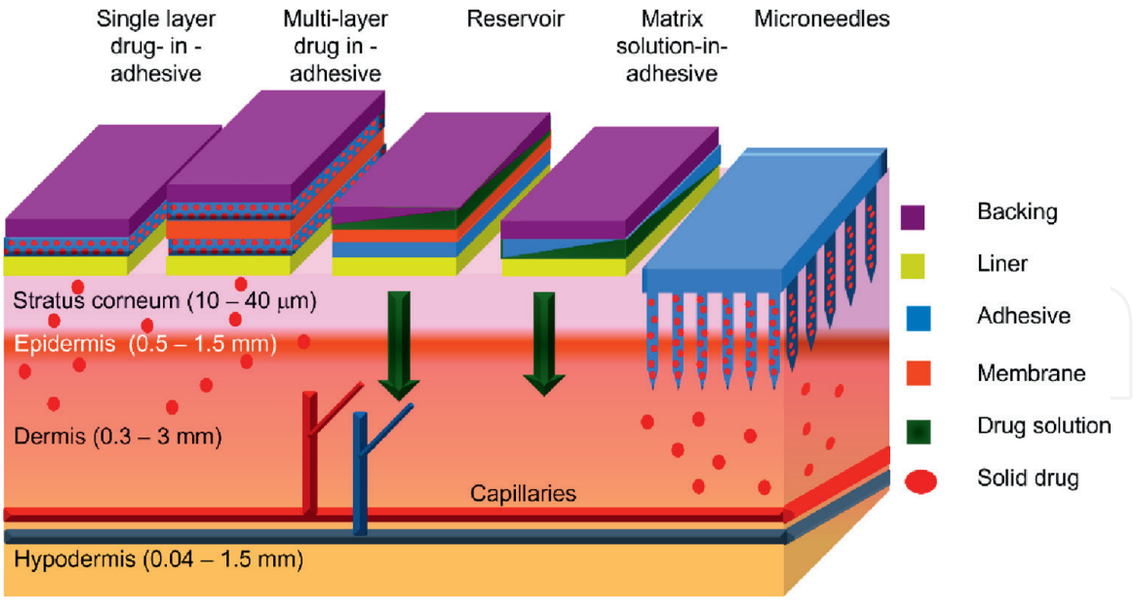

Figure 2.
Types of TDDS. This figure describes the different types of TDDS. Starting from left to right we have single-layer drug-in-adhesive and multi-layer drug-in-adhesive, which are similar in that they contain the drug in the adhesive layer and a solid-state, except for the multilayer, which has a membrane. Finally, we have the microneedle patches, which have penetration to the dermis, with biodegradable needles, from which the solid drug will be released. All these TDDS are intended for the active ingredient to travel to the capillaries between the dermis and the hypodermis.

- Where the confidence of administration may improve pain control. This may be useful in patients with cognitive failure or those who cannot self-medicate for analgesia.

- It can be used in combination with another potentiating strategy that produces a synergistic effect.

7.2 Transdermal patches are not used when

- Cure for acute pain is required.

- When a quick dose is needed.

- When the required dose is equal to 30 mg/24 h or less [23].

8. Advantages, disadvantages, and limitations

In **Table 3** we can observe the advantages and disadvantages of being treated with TDDS.

9. Permeation mechanisms

9.1 Passive (patches)

Patches belong to the first generation of transdermal delivery systems. Significant advances in patch technology have led to their everyday commercial use. Patches are

Component	Description	Desirable characteristics	Examples
Polymer matrix/drug reservoir/membrane	The function of the polymer is to control the release of the active agent. The choice of polymer will depend on the type of drug and the purpose of the device, they must be biocompatible and provide uniform and effective delivery of a drug over the intended lifetime of the product.	Not chemically reactive with the drug. The polymer should not decompose during its shelf life. Molecular weight and physicochemical properties should allow diffusion of the drug at the desired rate. The polymer and its decomposition products must be nontoxic. It must be biocompatible with the skin. The polymer must be easy to make and fabricate into the desired product. It must allow the incorporation of large quantities of the active agent.	PVA PE CE HPMCE ECE PMA PVP PEG
Drug	The physicochemical properties of the drugs must be taken into account since due to skin permeation, it is not possible to use all types of drugs.	Dosage less than 20 mg/day. Half-life in h of 10 or less. Molecular weight less than 400 Log P (octane - water) partition coefficient between 1 and 4. Skin permeability coefficient greater than 0.5 x 10^{-3} cm/h. Not irritating or sensitizing.	Captopril Metoprolol tartrate. Clonidine indapamide Propranolol hydrochloride Carvedilol Verapamil hydrochloride Nifedipine Buprenorphine Fentanyl
Permeation enhancers	Modify the biological barrier of the skin by interacting with the lipids of the stratum corneum to increase permeability to achieve higher concentrations.	They must not be toxic, irritating, or cause allergies. The duration of the effect should be predictable and reproducible. They must not have pharmacological activity with the body. Inert with the drug. They must work in a unidirectional way. Upon removal of the patch, the barrier properties should be reestablished. They must be cosmetically acceptable with an appropriate skin feel.	Terpenes Alcohols Glycols Pyrrolidones Sodium lauryl sulfate Vitamin C Oleic acid Penetratin

Pressure-sensitive adhesives	They are the component that adheres to the skin, through the application of a light force. They form interatomic and intermolecular forces of attraction at the interface, the material should be able to deform under slight pressure and when removed should not leave residues.	High biocompatibility. Good adhesion to oily, moist, wrinkled, and hairy skin. Good environmental resistance (water and humidity) Easy to remove from the skin. High moisture permeability to avoid excessive occlusion and for the drug itself. Not to be reactive with the drug.	Silicone-type adhesive. Polyisobutylene adhesive. Polyacrylate-based adhesive.
Backing laminates	Its purpose is to bind the entire system together and at the same time protect the drug reservoir from exposure to the atmosphere.	Pleasant appearance. Flexibility and need for occlusion. Chemical resistance. Biocompatible. Impermeable to drug and permeation enhancers.	Polyester. Siliconized and aluminized polyethylene terephthalate. Metalized polyester aluminum laminated with polyethylene.
Release liner	The strip prevents loss of the drug that has migrated into the adhesive layer during storage and protects the completed device against contamination.	Chemically inert. Resistant to deformation. Resistant to the environment during shelf life.	Nonocclusive base layer: Paper cloth Occlusive base layer: Polyethylene Polyvinyl chloride Nonstick: Silicone

Table 2.
Characteristics of the TDDS components [18–22].

Advantages	Disadvantages	Limitations
Painless. Noninvasive. They are not bulky and easy to handle and dispose of. Little or no gastrointestinal side effects. It avoids first-pass metabolism. Prevents the degradation of drugs by stomach pH. Self-administration. Increases bioavailability. Reduction of dosing frequency. Alternative for patients with impairment of common routes of administration (oral, IV). Therapy can be terminated when the device is removed.	Contact dermatitis (discontinuation of administration). High cost compared to tablets. You cannot use all drugs. It May cause allergic reactions. A water-lipid solubility between 1 and 3 (log P octanol/water) is necessary for permeation. Only potent drugs are useful candidates for this type of delivery.	They cannot deliver ionic drugs. Cannot have high blood/plasma drug levels. They cannot be developed for drugs of large molecular size. They cannot be developed if the drug or formulation causes skin irritation. Variation in absorption efficiency at sites other than the skin.

Table 3.
Advantages, disadvantages, and limitations of the TDDS [24–27].

passive permeation systems; drugs diffuse through a membrane from a region of high concentration to areas of low concentration. The rate of diffusion is proportional to the gradient but also depends on the properties of the administered molecule such as solubility, size, degree of ionization, and the adsorption surface. The drug is stored in the polymer and has contact on one side with the impermeable backing and on the other with the adhesive. Some designs employ the drug dissolved in a liquid or gel reservoir, which can simplify formulations [14, 17].

9.2 Active (microneedles)

A simple way to selectively permeabilize the stratum corneum is to pierce it with very short needles. Micro-needle (MN) matrices are minimally invasive drug delivery systems that have the advantage of avoiding the use of hypodermic needles, thus improving patient compliance combines bine the ease of use of a transdermal patch with the effectiveness of hypodermic needle and syringe administration [27, 28].

MN are multiple microscopic projections assembled on a support base or patch; the support must be flexible with characteristics dictated by the properties of the material from which they will be made. Generally ranging from 25 to 2000 μm in height, 50 to 250 μm in width and base, and 1 to 25 μm in tip diameter [27]. The needles must be of adequate length, width, and shape to avoid contact with nerves when inserted into the skin layers. MNs are made of a polymeric matrix, which eventually degrades, thus releasing the therapeutic molecules into the dermis layer in the skin, to reach the blood vessels.

MNs are designed to create transient aqueous conduits through the skin, thus improving the flow of molecules such as low molecular weight heparins, insulin, and vaccines, all without pain [29]. The advantages offered by MN technology are the fact that they do not cause bleeding, eliminate the variability of transdermal dosing of small molecules, minimal risk of introduction of pathogens through MN-induced holes, can be self-administered, and the ease of disposal of MN waste [27, 30].

10. Types of TDDS

See **Figure 2**.

10.1 Single-layer (Unilayer)

It is fabricated with three layers, a temporary liner in the lower, an adhesive in the middle, and a backing on the top, and Is called a Single Layer because the adhesive layer accomplishes two functions: the adhesion in the skin and a container for the active molecule.

10.2 Multilayer

It is like the single layer in that the adhesive layer is the same as the one containing the drug but differs in that it adds another layer of drug-adhesive, usually separated by a membrane. It also has a temporary liner and a permanent backing.

10.3 Reservoir

Unlike the unilayer and multilayer, this system has a separate drug layer. This layer is a liquid compartment containing the drug in solution or suspension separated by an adhesive layer. This patch also has a backing and a temporary liner. Its release kinetics is of zero order.

10.4 Matrix

This system has a drug layer of a semisolid matrix containing a drug solution or suspension. The adhesive layer surrounds the drug layer partially enveloping it.

10.5 Vapor

The adhesive layer of the patch contains oils or another vaporized solution for its release. They release essential oils for more than 6 h to be used in cases of decongestion, other patches improve the quality of sleep and reduce the number of cigarettes in a month [31, 32].

11. Properties affecting delivery

11.1 Physicochemical properties of penetrating molecules

11.1.1 Partition coefficient

A lipid/water partition coefficient, if 1 or greater is required for optimal transdermal permeability.

11.1.2 pH conditions

At moderate pH, the flux of ionizable drugs can be affected by changes in pH that alter the ratio of charged to uncharged species and their transdermal permeability.

11.1.3 Penetrating concentration

At a concentration higher than the solubility, the excess solid drug acts as a reservoir and helps to maintain a constant drug constitution for prolonged periods of time [33, 34].

11.2 Physicochemical properties of the delivery system

11.2.1 Release characteristics

The release mechanisms depend on whether the drug molecules are dissolved or suspended in the systems. Also on the partition coefficient of the drug from the delivery system to the skin and the pH of the vehicle.

11.2.2 Composition of drug systems

The composition of the system (bonded layers, thickness, polymers, and vehicles) not only affects the drug release rate but also the permeability of the stratum corneum due to hydration, making skin lipids or other effects that promote absorption [34].

12. Processing methods

12.1 Patches

Patch manufacturing methods vary according to the type and purpose of the drug to be administered. Transdermal patches are complex pharmaceutical forms, consisting first of an impermeable outer coating layer—whose function is to protect the formulation—a reservoir with the active ingredient and permeation potentiators, an adhesive film that allows its fixation to the skin, and on top of it a removable protective layer that must be removed before application [17, 35].

12.2 Microneedle arrays

The original MN fabrication methods involved clean-room sculpting of silicon-based structures, these have moved to low-cost fabrication methods [36] to make microneedles from metals, silicones, and polymers commonly found in FDA-approved devices. Microneedles offer a high range of possibilities in terms of delivery substances; in several studies, they have been dip-coated with a variety of compounds, including small molecules, proteins, DNA, and virus particles [28, 30, 37].

The shape and geometry of MN are very relevant during design and manufacturing. The needles should be able to be inserted into the skin without damage or breakage and should have the ideal length, width, and shape to avoid contact with nerves [38].

In general, four TDD strategies using MNs. These are solid, coated, soluble, and hollow MNs. Solid MNs are usually fabricated from sheets of solid materials either stainless steel or biocompatible materials, then electropolished. MNs used in antigen delivery studies are prepared as single rows of 5 needles. The needle should have the geometry of a pointed tip on a long elongated shaft, 50 mm thick and 200 mm wide at the base [11].

A recent method in MN fabrication is the use of biocompatible polymers on flexible backings that can be water-soluble. The patches dissolve completely in the skin; because the backing is water-soluble, there is no need to remove the device, ensuring total dissolution and reducing biohazard waste. In addition, due to the flexible backing, the patch can adapt to the skin and localize the insertion forces, this increases the ability of each MN to perforate the SC [18].

High-precision three-dimensional (3D) printing is a novel method of constructing solid micromodels. However, this method is still in its early stages both in the research field and in the pharmaceutical industry [39]. Another recent fabrication method for dissolving needles is the droplet air blowing method. Stamped droplets of polymer can be stretched between two plates. By blowing air between the two plates. The advantages of this method are the mild temperature and pressure requirements and the short fabrication time [40, 41].

13. Application according to the duration of pain

13.1 Acute

The treatment of acute pain should act on the cause, although pain is only a symptom, the sensation of pain should be treated as part of the treatment. In mild pain, the first option is paracetamol. When the pain is moderate, NSAIDs alone or associated with opioids are the best option, and if they are to be avoided, the association of paracetamol with minor opioids is an acceptable alternative. Analgesic escalation prolongs the patient's suffering. Therefore, according to the assessment of pain intensity, prompt action should be taken [42].

For the treatment of acute pain, there are several options available on the market patches, whose active components are ketoprofen, diclofenac, and capsaicin (mild pain); buprenorphine and fentanyl are normally used in cases of chronic pain, in people who are expected to need analgesics 24 hours a day for a long time and who cannot be treated with other drugs.

These options in patch presentation offer advantages such as the patient can apply the patch himself without the need of a professional, the dosage is sustained, does not cause pain, avoids the hepatic metabolism step, is comfortable to wear, and can continue with daily activities.

13.2 Chronic

Chronic pain is associated with malignant (cancer) or nonmalignant conditions. TDDS are effective for the treatment of this type of pain, as the amount of intravenous and oral treatments can become harmful in a short period of time, causing mostly gastrointestinal tract problems. As we have seen throughout this chapter, the advantages of TDDS are also applied to treatment over long periods, although it implies a risk-benefit because these transdermal treatments can also give rise to adverse effects, although of lesser impact.

The approved TDDS for clinical use are composed of opioids, such as buprenorphine (BuTRANS, Transtec) and fentanyl (Duragesic). In addition, these systems can be directed to the elderly patient (> 65 years), we must remember that in these patients the metabolism decreases and the ratio in the body of fat/muscle is altered, consequently the doses of drugs should be decreased, in contrast to those of a young

adult, because in the treatment of chronic pain they may suffer from respiratory depression when opioids and non-opioids are delivered by other routes, being an advantage a TDDS of prolonged release. TDDS for chronic pain are contraindicated in the management of acute and postoperative pain [43].

13.2.1 TDDS buprenorphine

Buprenorphine is a semisynthetic opioid, lipophilic in nature, which is intended to provide analgesia. The effect of this drug is of long duration (6–8 h), due to the dissociation of buprenorphine from the mu receptor. On the other hand, the buprenorphine transdermal patch has a slow onset (12–24 h) and a long duration (3 days) [44].

Clinical trials revealed that in patients with moderate to severe chronic pain it is possible to make a treatment switch from weak opioids to transdermal buprenorphine without problems. For patients who respond favorably to this form of release, an example of this is by reporting uninterrupted sleep for more than 6 h compared to a placebo group (without the active ingredient). The mean duration of treatment has been up to 7.5 months of analgesia in 90% of patients. In addition, it has been observed that it can work for neuropathic and nociceptive pain. The safety profile (renal), analgesia over long periods, and is a noninvasive treatment make it an attractive choice for the treatment of chronic pain in elderly patients [44].

Long-term treatment of chronic pain with transdermal buprenorphine has been evaluated for its efficacy and tolerability in cancer and non-cancer patients with moderate to severe pain. Buprenorphine 35 μg/h patches and buprenorphine sublingual tablets (0.2 mg) were used as rescue medication. The duration of maximum participation in cancer patients was 3.4 years and in non-cancer patients 5.7 years. Treatment adherence was 78.7%, with most patients (65.9%) managing their pain with only the patch or taking no more than 1 sublingual tablet daily as adjuvant. Ninety percent of patients reported pain relief and the patch was well tolerated [45].

However, these treatments are not free of adverse effects, since the typical conditions of opioid use have been reported, such as nausea, dizziness, vomiting, constipation, and tiredness, in addition to local effects such as erythema, pruritus and exanthema [44, 45].

13.2.2 TDDS fentanyl

In 1990, the FDA approved the first formulation of an opioid pain medication in a fentanyl-containing patch with a 72 h duration. Fentanyl TDDS is effective and tolerated, forming a depot in the most superficial layers of the skin before entering the microcirculation. Therapeutic concentrations are obtained 12–16 h after patch application and decrease slowly, with a half-life of 16–22 h after patch removal. However, transdermal fentanyl should be used prior to patient sensitization with oral or parenteral opioids to avoid exacerbation of pain or opioid-related adverse effects, which is a disadvantage compared to transdermal buprenorphine [46].

Fentanyl patches were studied in patients with moderate to severe nom-cancer related chronic pain. With starting doses of 12.5 μg/h to be later increased by 12.5 μg/h or 25 μg/h if the average pain score was equal or more than 4 in the first 72 h, the patients' pain relief was notorious, from a scale of 7 out of 10 of pain assessment it was reduced to 2 out of 10, after 12 weeks. In the treatment of soft tissue cancer chronic pain, the relief of pain comes with a 25 μg/h dose patch, within the first 72 h and the severity of pain after treatment decreased significantly [47].

We must remember that these TDDS have their benefit, but also their risk, since the use of this TDDS has reported adverse effects in up to 72% of cases, such as nausea, vomiting and drowsiness. In addition, another effect related to opioids and the transdermal form of the drug is hypoventilation, so its use should be considered in patients with preexisting conditions of lung damage, such as emphysema. Other serious effects of TDDS include cognitive and physical impairments such as confusion or abnormal coordination [48].

14. Conclusions and perspectives

There are several patch options available on the market for the treatment of acute and chronic pain, TDDS are an attractive option because of its advantages over other systems (pills, tablets) and it promotes pharmaceutical adhesion because it is a noninvasive method of dosage and the self-administration. However, considerations must be made in diminishing the secondary and adverse effects of the current ones or to combine new nanosystems for the drug encapsulation for better control of the release. In future outlooks, new smart transdermal delivery systems are being developed that include external stimuli for the release of the drug.

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Conflict of interest

The authors declare no conflict of interest.

Notes/thanks/other declaration

We have no further statement to make.

Nomenclature

PVA	Poly (ethylenvinylacetate)
PE	Polyethylene
CE	Cellulose
PMMA	Polymethyl methacrylate
PVP	Polyvinylpyrrolidone
PEG	Polyethylene glycol
HPMCE	Hydroxypropyl methylcellulose
ECE	Ethylcellulose

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