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Advances in Transdermal Drug Delivery System

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Transdermal drug delivery system (TDDS) have played significant role in medical practice ever since the first scopolamine transdermal patch for motion sickness was approved by the US Food and Drug Administration in 1979. TDDS helps in sustained release of drugs through the skin in a predetermined and controlled rate , which ins case of many drugs is equivalent to that of a continuous IV infusion, but in a noninvasive system TDDS bypasses the enterohepatic circulation, thereby providing a more reliable and efficacious therapeutic effects. First-generation of transdermal delivery systems have continued their steady increase in clinical use for delivery of small, lipophilic, low-dose drugs. Second-generation delivery systems using chemical enhancers, non-cavitational ultrasound and iontophoresis which can control delivery rates in real time provides improved their efficacy. Whereas, use of microneedles, thermal ablation, microdermabrasion, electroporation and cavitational ultrasound in third-generation delivery systems further enhanced permeability skin's barrier layer stratum corneum. Age, skin condition at the area of application, physicochemical factors of the drug and environmental factors are key parameters to be considered for the development of TDDS. Basic components of TDDS include polymer matrix, membrane, drug, penetration enhancers, pressure-sensitive adhesives, backing laminates, release liner, etc. Transdermal patches can be divided into various systems like reservoir system, matrix system and micro-reservoir system. During development transdermal patches undergo various tests that determine the adhesion and, physicochemical properties, *in vitro* drug release, *in vitro* skin permeation and skin irritation, and the stability. Recently, nanoparticles have been introduced into a wide array of biomedical devices as the nanocarriers of drugs for diagnostic and therapeutic applications. In TDDS, nanoparticles could significantly improve the penetration of macromolecular drugs across the stratum corneum, with the potential to reduce immunogenicity and improve the bioavailability. The most common nanoparticles used TDDS are self-assembled liposomes, solid-lipid nanoparticles, polymeric micelles, and inorganic nanoparticles. Compared with organic nanoparticles, inorganic nanoparticles offer higher physiochemical stability, easier surface functionalization, and possess a tunable particle size and varied morphology. Thus, developing novel transdermal nanodevices based on inorganic nanoparticles is one of the fastest growing fields in nanomedicine.

One of the useful applications of Microneedle technology is development Dissolving Microneedle patches that represent next generation TDDS. These patches use fine needles made up of polymers soluble in vivo and active ingredients. These microneedles, penetrate stratum corneum and dissolve inside skin to efficiently deliver active ingredients with minimally invasive procedures. These patches have been used to successfully in skin care cosmetics to improve skin wrinkles.

Recently, developed 'Passport' patches based on microporation technology show great promise in transdermal delivery with minimally invasive approaches. In these devices, a single use 'porator' is used to painlessly ablate stratum corneum in milliseconds to create micropores through which the adhesive patches deliver the active ingredients. This minimally invasive technology will not compromise skin's innate immune system and micropores also turnover quickly. These patches are capable of delivering drugs as small as 150 kd to macromolecules such as insulin hormone, a widely used anti-diabetic drug showing great promise to deliver difficult deliver drug efficiently and with less side effects.