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DERMAL DRUG DELIVERY THROUGH NANOCARRIERS

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ABSTRACT

Nanocarriers have been explored for delivering drugs and other bioactive molecules for well over 35years. Since the introduction of a nanoliposomal delivery system for the cancer drug doxorubicin, several products have been approved worldwide. The majority of these products focus on cancer chemotherapy, and utilize the size advantage of nanocarriers to obtain a favourable distribution of the drug carrier in the human body. In general, such carriers do not sustain drug release over more than a few days at best. A variety of nanocarriers have been studied, and their advantages and shortcomings are highlighted. The achievement of sustained release of bioactive molecules opens new doors in nanotherapeutics.

KEYWORDS: Drug delivery, Nanocarriers, Sustained drug release, Targeting.

INTRODUCTION

The human body's largest and most accessible organ is the skin. The average person's skin weighs 4.5–5 kg (16% of body weight), and it covers an area of around 2 square metres. Additionally, it receives a third of the blood supply overall. The skin is a multi-layered organ with numerous histological layers according to anatomy. Skin makes up roughly 16–18% of the average body weight and serves as an anatomical barrier between the body and its surroundings. The epidermis is the layer that sits on top, and the dermis is the layer that lies beneath. Subcutaneous fatty tissues are located underneath the dermis. The skin permeation coefficient (kp) measures how well skin conducts a specific chemical from a specific carrier.[1] Molecules in touch with the skin's surface have three potential routes by which they can enter: either directly across the stratum corneum, through the sweat ducts, or through the hair follicles and sebaceous glands (together known as the shunt or appendageal route).

A drug delivery system (DDS) can be defined as a device or a formulation that is capable of introducing a therapeutic substance into the body in a manner that enhances its safety and efficacy over the two “standard” methods of drug administration: oral tablets and intravenous (IV) injections. The improved efficacy can be due to greater localization of drug, enhanced bioavailability of the drug or sustained duration of action. Of these, sustained release delivery systems

have been intensely studied for many decades and have enjoyed some success in the pharmaceutical arena. A sustained release medication delivery system is one that can have a prolonged therapeutic effect by slowly releasing the therapeutic material over a lengthy period of time (days or months) following administration of a single dose. Sustained release dose formulations have a number of benefits, which include:

1) Less frequently administered
2) Less negative consequences
3) Consistent blood and plasma levels of medication absorption
4) Increased patient adherence.

Therefore, for the optimal design of sustained release dosage forms, both physico-chemical (size, dosage size, solubility, partition, etc.) and biological (half-life, absorption, distribution, metabolism, etc.) variables must be taken into consideration. Additionally, appropriate in vitro release techniques should be found in order to assess the release of various dose forms, including nanoparticles.

A major challenge in the evaluation of release from nanoparticles is the lack of a universal method for quantifying release *in vitro*. This has hindered the interpretation of *in vitro* release data and thus the comparison between different classes of nanocarriers such as liposomes, micelles and polymeric nanoparticles. Some of these methods reported in the literature include microdialysis fractional dialysis, reverse dialysis, sample and separate methods. Different experimental techniques that are used to evaluate release of drugs from nanoparticles are reviewed elsewhere.[2]

DECREASING DOSING FREQUENCY

In preclinical and clinical stages of cancer treatment, EG-functionalized nanoparticles as carriers of chemotherapeutic drugs have been investigated with remarkable effectiveness; some, especially PEGylated liposomes and polymers, have already received FD approval.PEGs, also known as polyethylene glycols, are frequently used in cosmetics as humectants, emulsifiers, skin conditioners, and cleaning agents. Numerous PEG compounds are used for purposes beyond from cosmetics.ethylene glycol polymers. Therapeutic agent half-lives can be extended using the PEGylation procedure, which also enhances their pharmacokinetic (PK) profiles and lowers the number of times they need to be dosed. The protein corona composition of PEGylated Nanoparticles (NPs) has a significant impact on their surface properties, which in turn have an impact on the tumour accumulation and drug clearance qualities. The surface properties of NPs can be altered to increase their tumour absorption without compromising circulation time by adjusting the size and complexity of PEG molecules as well as by attaching targeted moieties. The creation and utilisation of PEGylated NPs for tumor-targeted medication delivery in animal models and clinical settings are the main topics of this review.[3]

FOLLICULAR TARGETING

Acne vulgaris (acne) is a common and chronic inflammatory skin disorder occurring within pilosebaceous units in the skin, including hair follicles and sebaceous glands. The primary causal factors during the development of acne include hyperactivity of the sebaceous gland, follicular epidermal hyperproliferation and inflammation of pilosebaceous units caused by pathogens, such as Propionibacterium acnes.

Topical therapy is considered the first option in the treatment of mild and moderate acne due to the drawbacks of systemic medication delivery, such as adverse effects of drugs. Benzoyl peroxide (BPO) is one of the active ingredients

in medication that has been prescribed for the topical treatment of mild and moderate acne since the 1960s. Its main mechanism of action is related to antimicrobial activity against Propionibacterium acnes in sebaceous follicles. However, BPO has many side effects, such as skin dryness, itching, burning, erythema, scaling, and contact allergy.[4] BPO also causes mild to moderate skin irritation depending on the amount applied onto the skin surface and the type of medication formulation. Due to the aforementioned side effects, patient compliance to therapy may be low.[4]

PROTECTING LABILE ACTIVE FROM DEGRADATION

Due to the global ozone layer loss, photodegradation has emerged as a crucial issue in people's day-to-day lives. One of the most prevalent degradative processes, photodegradation results in the loss of photo-labile antibiotic, therapeutic, cosmetic, and pesticide activities. Therefore, more of these compounds must be utilised to maintain a concentration level above the minimal effective concentration (MEC), which would lower commercial profit. Additionally, this process may produce dangerous photodegradation chemicals that are discharged into the environment and cause toxicity in the ecosystem, including humans. To lessen the impact of photodegradation on photo-labile chemicals, a variety of techniques have been devised, such as changing the chemical structure of insecticides or adding UV absorbers to cosmetic formulations. These techniques do have certain limitations, though. For instance, improving photostabilization without altering biological activity or pesticide target specificity may not be possible purely through structural changes. Additionally, the inclusion of UV absorbers in sunscreen formulations for cosmetics runs the risk of triggering skin irritations, phototoxic responses, and photoallergies. Therefore, an appropriate photoprotection approach is still needed.[5]

To control the release, increase enzyme activity, and boost biodistribution of the encapsulated active substances, nanocarriers have recently received extensive research for their wide range of industrial uses, including the cosmetic, agricultural, pharmaceutical, and food industries. The use of nanocarriers for photoprotection hasn't been addressed yet, though. Solid lipid nanoparticles (SLN), despite they have been shown in certain studies to be capable of photoprotection, have a small payload, a high rate of encapsulated chemical leakage, and a poor photoprotection capacity. Consequently, a novel nanocarrier system with a large payload and high capacity for photoprotection is required.[6]

CONCLUSION

Both dendritic core-multishell nanotransporters and SLNs are effective drug delivery systems for the skin. Small-sized CMS nanotransporters were the most promising because to the superior particle surface to volume ratio. This method even defeats the impact of combining SLN matrix lipids with epidermal lipids, which can facilitate medication penetration in particular. Most of these products are aimed at cancer treatment, and they make use of nanocarriers' size advantage to achieve a favourable distribution of the drug carrier in the body. Such carriers typically do not maintain medication release for more than a few days at most. Numerous nanocarriers have been investigated, and their benefits and drawbacks have been outlined. The accomplishment of sustained bioactive.

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