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Applications of Photodynamic Therapy for Cancer in Dogs and Cats

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Introduction

Neoplasms that develop on their own affect a large number of animals. In veterinary medicine, some of the most common treatments include surgery, chemotherapy, and radiation. However, the scientific community has been inspired to look for new, safer, and more effective treatments because of the side effects of these therapies and the inconsistent success of their responses. Hematoporphyrin derivatives in solid tumors in dogs and cats were investigated by Dougherty and colleagues, who first recognized the potential benefits of photodynamic therapy (PDT), a treatment that combines light with chemicals known as photosensitizers or photosensitizing agents in veterinary medicine. However, PDT's application in veterinary oncology was postponed due to the availability of chemotherapy and radiotherapy. PDT has recently garnered widespread interest due to promising results and technological advancements [1].

Description

PDT's advantages include its lack of carcinogenic or mutagenic effects, low toxicity, and minimal invasiveness. PDT produces selective cytotoxicity in tumor cells, making it safer than other treatment options for non-neoplastic tissues far and near the neoplasms. Although PDT can be repeated without causing harm to normal tissues or eliciting drug resistance, a satisfactory result may only be achieved after one application. Another benefit is that PDT can adjust and hinder drug obstruction pathways and desensitize cells impervious to standard treatments. In addition, the PDT typically employs non-ionizing radiation and causes a small amount of cytotoxic DNA damage. The three non-toxic essential components of the photodynamic reaction are oxygen, visible light, and the photosensitizer. The photosensitizer is administered to initiate PDT and typically accumulates primarily in the target tissues. The molecule is activated when exposed to light of a particular wavelength and energy, which initiates a photo physical and photochemical process that results in the production of reactive oxygen species (ROS). The photosensitizer enters an excited state upon activation. There are two kinds of photodynamic reactions that occur in this higher energy state. In the sort 1 response, the photosensitizer communicates with biomolecules shaping revolutionaries and different ROS. Singlet oxygen is produced when energy is transferred to oxygen in the type 2 reaction. The photodynamic reaction is the result of this process. The neoplasm benefits from the therapeutic effect of high ROS production. Cancer cell death, which may involve apoptosis, necrosis, or autophagy, is caused by irreversible oxidation. Moreover, vascular and inflammatory responses have the potential to alter the tumor microenvironment. PDT has the potential to cause endothelial cell damage and the occlusion of tumor vessels, limiting the supply of nutrients and causing ischemia an additional mechanism that favors the death of cancer cells. Additionally, PDT promotes adhesion molecules like E-selectin and intercellular adhesion molecule 1 (ICAM-1) as well as a number of pro-inflammatory cytokines like interleukins and tumor necrosis factor (TNF-). The involvement of immune modulators suggests that immunity might be activated. By activating the immune system, PDT mediators can theoretically destroy tumor tissue and contribute to the body's elimination of cancer cells, potentially preventing recurrence or metastasis [2].

The size, location, biology, oxygenation of the tissue, and dosimetry of the neoplasm are just a few of the factors that can affect the outcome of treatment. In point of fact, the photosensitizer is thought to be the most significant factor. As a result, a number of authors revised the characteristics of an ideal photosensitizer. The photosensitizer ought to be a chemically pure substance that has absorbance spectra that are compatible with photo activation within the therapeutic window of 600–800 nm, is non-toxic when there is no light, has a high singlet oxygen yield, preferentially accumulates in the tumor, and is quickly excreted. In addition, the formulation needs to be adaptable and safe for oral, topical, and parenteral administration.

PDT was approved by the European Medicines Agency (EMA) and the Food and Drug Administration (FDA) of the United States to treat neoplasms and non-malignant diseases in dermatology, ophthalmology, urology, and pneumology. In veterinary medication, a few preliminaries were performed, regularly with empowering results. Nonetheless, there is no specific recommendation or approval for PDT. In veterinary oncology, PDT is a treatment option that is not widely known. However, feline squamous cell carcinoma is the indication for its use. Nevertheless, PDT may be used to treat other cancers. The purpose of this review is to provide an overview of the various uses of PDT in veterinary medicine, from clinical applications to the most recent developments for dogs and cats.

The majority of photosensitizers have unique photodynamic and photodiagnostic capabilities thanks to their tetrapyrrole structure. The chemical structure of phenothiazine dyes like toluidine and methylene blue, cyanines, and polycyclic aromatic compounds like hypericin are among the other common photosensitizers. Porfimer sodium, also known as Photofrin, was the first tetrapyrrole photosensitizer to be utilized in clinical settings. From a synthetic perspective, it permits structural changes and modifications to peripheral pyrrolic positions that may result in new macrocycles. Hypericin, benzoporphyrin derivatives, and various other porphyrins, chlorins, bacteriochlorins, and phthalocyanines make up the second generation of photosensitizers.These are better-optimized molecules that have higher ROS yields, higher purity, and higher absorption in the therapeutic window. As a palliative or local treatment for patients with advanced head and neck cancer who did not respond to previous therapies and were not indicated for chemotherapy or radiotherapy. It was thought to be 100 times more effective than first-generation photosensitizers due to its high singlet oxygen yield and absorption band at a deeper penetrating wavelength. Regardless of the benefits according to a photochemical perspective, there were shortcomings related with its clinical application [3-5].

Conclusion

Numerous therapeutic milestones have been reached by veterinary medicine; However, cancer remains a therapeutic challenge, threatening the quality of life of patients and necessitating efforts on the part of their owners.

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However, domesticated animals are members of the family. Their owners are always looking for less invasive treatments because they are extremely concerned about their animals' health and quality of life. The application of PDT is used to treat a wide range of cancers in veterinary oncology. However, therapeutic protocols are still up for debate as a result of a lack of research, and the use of PDT in veterinary medicine is not yet routinely used. This difference with overall administrative endorsement for treating different harmless and threatening sicknesses in human medication.

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Conflict of Interest

The authors declare that there is no conflict of interest associated with this manuscript.

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