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Review Article

Recent advances in the local drug delivery systems for improvement of anti-cancer therapy

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ABSTRACT

The conventional anticancer chemotherapies not only cause serious toxic effects but also produce resistance in tumour cells exposed to long-term therapy. During the last few decades, scientists have been exploring new anticancer drug delivery systems such as nanoparticle-Based drug delivery, liposomes and hydrogels, Targeted drug conjugates to improve bioavailability, reduce drug-dose requirement, decrease multiple drug resistance, and save normal cells as non-specific targets. Hopefully, the development of novel drug delivery vehicles (nanotubes, liposomes, supramolecules, hydrogels, and micelles) will assist in delivering drug molecules at the specific target site and reduce undesirable side effects of anticancer therapies in humans. Nanoparticles and lipid formulations are also designed to deliver a small drug payload at the desired tumour cell sites for their anticancer actions. This review will focus on the recent advances in drug delivery systems and their application in treating different cancer types in humans.

Keywords: Southeast Asian countries, ASEAN, veterinary use, GHTF, AMDD

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1. Introduction

Anti-cancer therapy system is designed to address the challenges associated with traditional systemic drug administration in cancer treatment, such as off target effects and limited drug accumulation at tumour site. By utilizing various innovative technologies, including nanoparticles, researches aim to optimize drug distribution, release kinetics and targeting precision. This introduction provides an overview of the recent advances in local drug delivery systems and their potential to revolutionize. Anti-cancer therapy by improving efficiency and patient quality of life.

Cancer: Cancer is a disease characterized by uncontrolled

multiplication and spread of abnormal forms of the body's own cells.

- Study of cancer is known as Oncology.
- Hippocrates coined the Greek word Karakinos.

Tumour:

A tumour is abnormal mass or growth of tissue that serves no specific purpose. It can develop when cells grow and divide too quickly. Tumours can be located anywhere in body. They grow and behave differently depending on whether they are benign (noncancerous) or malignant (cancerous).

Tumours are two types:

Benign tumour

Malignant tumour

1. Benign tumour:

A benign tumour is made up of cells that don't threaten to invade other tissues. The tumour cells are contained within the tumour and aren't abnormal or very different from surrounding cells. Usually, benign types of tumours are harmless unless they are:

Pressing on nearby tissues, nerves, or blood vessels

- Taking up space in the brain
- Causing damage
- Causing excess hormone production

Common benign tumours include:

- Fibroids
- Lipomas
- Adenomas
- Haemangiomas

Doctors may need to surgically remove benign tumours. While they are not cancerous, some of these masses can grow very large if left untreated sometimes up to several pounds. Tumours that take up space become dangerous when they compress critical structures like the airway (trachea) or those inside the brain, pushing on essential areas enclosed in the skull.

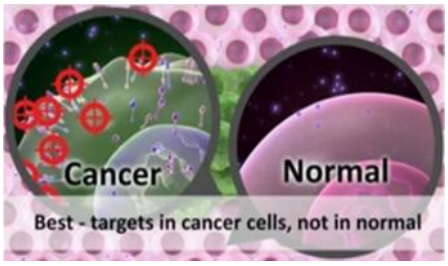

Fig 1. Difference between cancer cells and normal cells

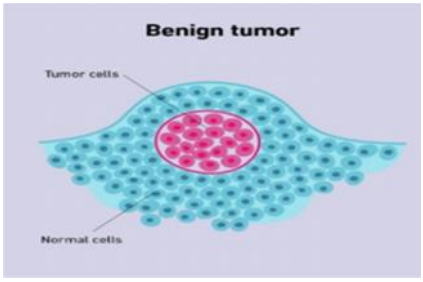

Fig 2

Fig 3

2. Anti-Cancer Therapy

Definition: Anti-cancer therapy is medication that is used to destroy, kill, shrink, or slow the growth of cancer cells.

Types of anti- cancer therapy:

- Surgery
- Radiation therapy (photodynamic therapy).
- Chemotherapy (hormonal therapy).
- Biologic therapy (immunotherapy).

Surgery: Surgery, when used to treat cancer, is a procedure in which a surgeon removes cancer from body. Surgeons are medical doctors with special training in surgery.

Radiation Therapy (Photodynamic Therapy):

Radiation therapy (also called radiotherapy) is a cancer treatment that uses high doses of radiation to kill cancer cells and shrink tumours. At low doses, radiation is used in X-rays to see inside body, as with X-rays of teeth or broken bones.

Photodynamic therapy: Photodynamic therapy uses a drug that is activated by light, called a photosensitizer or photosensitizing agent, to kill cancer cells. The light can come from a laser or other source, such as LEDs. Photodynamic therapy is also called PDT. PDT is a very safe and effective treatment when it's used for conditions it's been officially approved (licensed) to treat. During PDT, pain often manifests as a burning, stinging or prickling sensation and usually peaks in the first minutes of treatment and declines significantly after eight hours. The most common side effect of PDT is sensitivity to bright lights and sunlight. These reactions caused by PDT light can show up on the skin where the drug is applied. They usually involve redness and a tingling or burning sensation.

Chemotherapy (Hormonal Therapy):

Chemotherapy (also called chemo) is a type of cancer treatment that uses drugs to kill cancer cells. Chemotherapy works by stopping or slowing the growth of cancer cells, which grow and divide quickly. Chemotherapy is used for two reasons:

Treat cancer: Chemotherapy can be used to cure cancer, lessen the chance it will return, or stop or slow its growth.

Ease cancer symptoms: Chemotherapy can be used to shrink tumours that are causing pain and other problems.

Hormonal Therapy:

Hormone therapy is a cancer treatment that slows or stops the growth of cancer that uses hormones to grow. Hormone therapy is also called hormonal therapy, hormone treatment, or endocrine therapy. Hormone

therapy is used to treat prostate and breast cancers that use hormones to grow. Hormone therapy is most often used along with other cancer treatments. The types of treatment that depend on the type of cancer, if it has spread and if it uses hormones to grow, and if you have other health problems.

3. Chemotherapy

Biologic therapy (immunotherapy):

Biological therapy for cancer is a type of treatment that uses the body's immune system to kill cancer cells. Biological therapy for cancer can treat many types of cancer. It can prevent or slow tumour growth and prevent the spread of cancer. When cancer spreads, it's called metastatic cancer. Biologic therapy for cancer often causes fewer toxic side effects than do other cancer treatments.

Immunotherapy:

Immunotherapy is a type of cancer treatment that helps your immune system fight cancer. The immune system helps your body fight infections and other diseases. It is made up of white blood cells and organs and tissues of the lymph system. Immunotherapy is a type of biological therapy. Biological therapy is a type of treatment that uses substances made from living organisms to treat cancer.

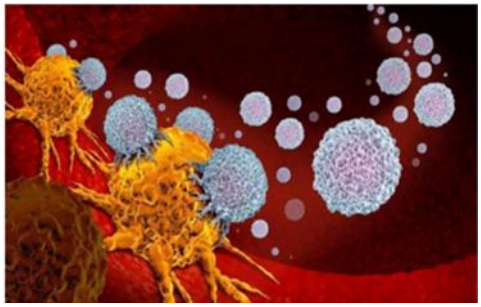

Fig 3 Biologic therapy

Advantages:

Enhanced efficiency.

- Reduced systemic toxicity.
- Improved drug delivery.
- Personalized treatment.
- Extended drug release.
- Reduced resistance.
- Improved quality of life.
- Potential for early detection.

Disadvantages:

- Fatigue
- Anemia
- Hair loss
- Nausea
- Skin problems
- Lowered blood counts
- Pain at the surgery site

Advance Anticancer Therapy

- Nanoparticles-Based drug delivery.
- Liposomes and hydrogels.
- Targeted drug conjugates.

NANOPARTICLE-BASED DRUG DELIVERY:

- Nanoparticle-based drug delivery is a cutting-edge approach in the field of medicine that involves using nanoparticles as carriers to deliver therapeutic agents, such as anti-cancer drug, to specific target sites within the body.
- Nanoparticles are spherical, polymeric particles composed of natural or artificial polymers.
- These nanoparticles are typically in the range of 1 to 100 nanometers in size and can be engineered to carry drugs, genes, or other therapeutic molecules.
- Nanoparticles can be designed to specifically target cancer cells or tumour tissues. Ligands or antibodies can be attached to the nanoparticle surface.

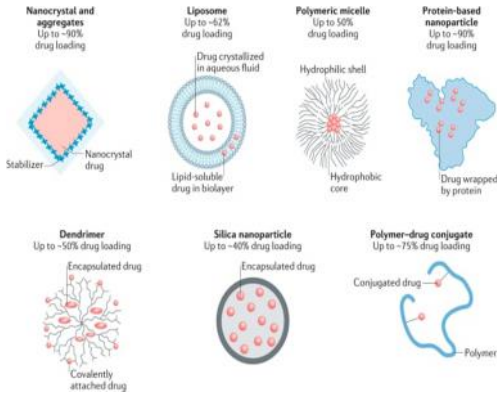

Fig 4. Nanoparticle based drug delivery

Liposomes and hydrogels:

- **Liposome:** A liposome is a spherical shaped vesicle that is composed of one or more phospholipid bilayers, which closely resembles the structure of cell membranes. The ability of liposomes to encapsulate hydrophilic or lipophilic drugs have allowed these vesicles to become useful drug delivery systems.
- **Hydrogels:**
  Hydrogels are three-dimensional network composed of hydrophobic polymers synthesized by crosslinking water-soluble polymers. Hydrogels can retain a large quantity of water within their network without disturbing their original structure. This imparts flexibility and swelling properties to the hydrogel structures.
- Liposomes and hydrogels are both promising approaches for delivering anti-cancer therapies. Liposomes are small vesicles that can encapsulate drugs, while hydrogels are gel like materials that can hold drug within their structure.
- These delivery systems can improve drug targeting, reduce side effects, and enhance drug stability.

- Liposomes can be designed to release drugs at specific sites, while hydrogels can provide sustained release. Both methods contribute to advancing anti-cancer therapies.

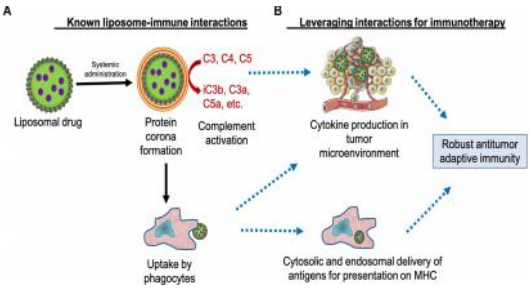

Fig 5. Liposomes and hydrogels

TARGETED DRUG CONJUGATES:

- Targeted drug conjugates are a type of anti-cancer therapy that combines a specific targeting molecule with a cytotoxic drug.
- The targeting molecule recognizes and binds to cancer cells surface markers, allowing for selective delivery of the drug to the tumour cells.
- Antibody-drug conjugates (ADCs) are a well-known example of targeted drug conjugates.

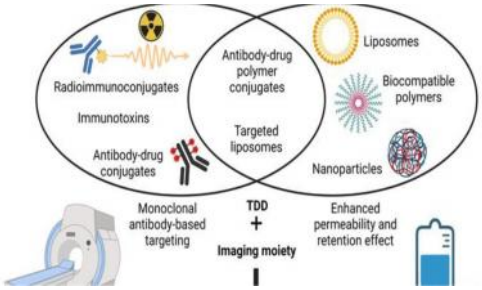

Fig 6. Targeted drug conjugates

4. Conclusion

In conclusion, anti-cancer therapy has witnessed remarkable progress over the years, driven by advancements in research, technology, and innovative treatment approaches. From traditional chemotherapy to targeted therapies, immunotherapies, and precision medicine, the landscape of cancer treatment has evolved significantly. The development of targeted drug conjugates, nanomedicine, and advanced delivery systems like implantable devices and liposomes, has enabled more precise drug delivery and minimized damage to healthy tissues. Moreover, the integration of artificial intelligence and data analysis has opened new avenues for identifying treatment strategies and predicting patient outcomes.

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