NANOMATERIALS AS DRUG CARRIERS FOR CANCER THERAPY

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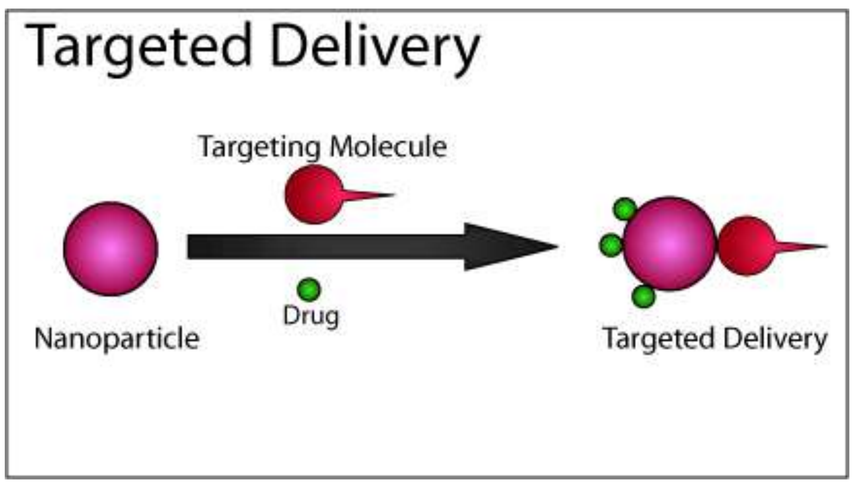
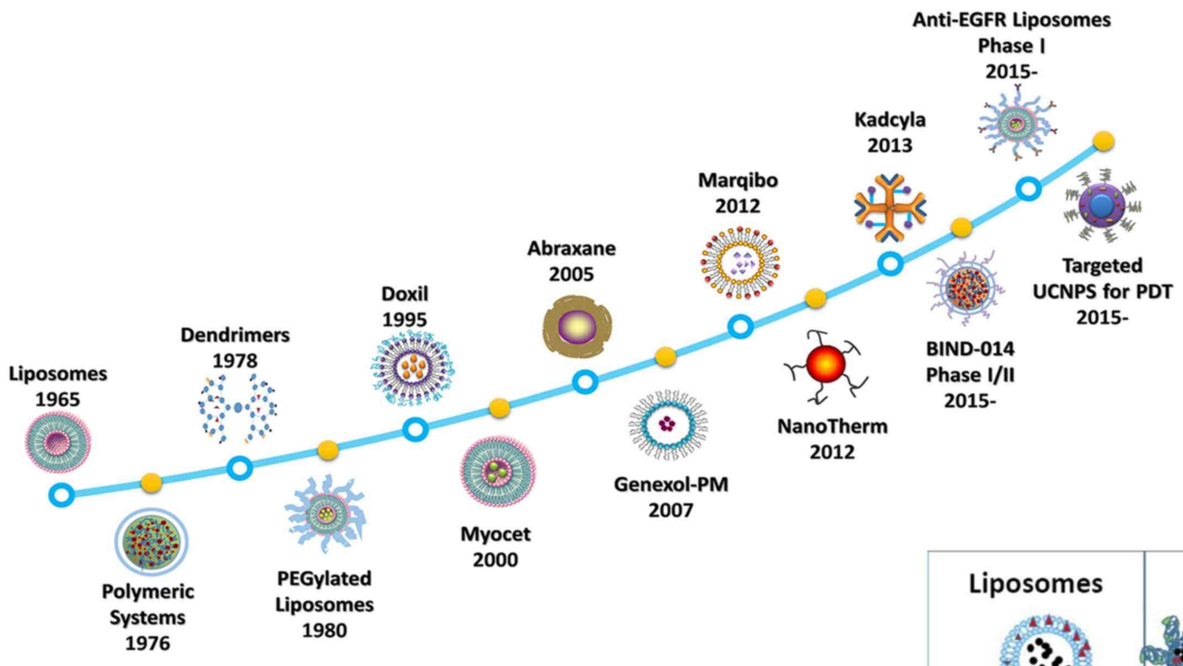
ABSTRACT

Cancer is a leading cause of death and poor quality of life globally. Even though several strategies are devised to reduce deaths, reduce chronic pain and improve the quality of life, there remains a shortfall in the adequacies of these cancer therapies. Among the cardinal steps towards ensuring optimal cancer treatment are early detection of cancer cells and drug application with high specificity to reduce toxicities.

Nanotechnology has the potential to increase the selectivity and potency of chemical, physical, and biological approaches for eliciting cancer cell death while minimizing collateral toxicity to nonmalignant cells. Materials on the nanoscale are increasingly being targeted to cancer cells with great specificity through both active and passive targeting. In this review, we summarize recent literature that has broken new ground in the use of nanotechnology for cancer treatment with an emphasis on targeted drug delivery.

The ability to decorate nanomaterial shells with multiple chemically or physically active components permits the delivery of different drugs. Therefore, nanomaterial drug carriers can be organized and optimized for site-specific chemotherapy, thermotherapy, photodynamic therapy, and radiotherapy.

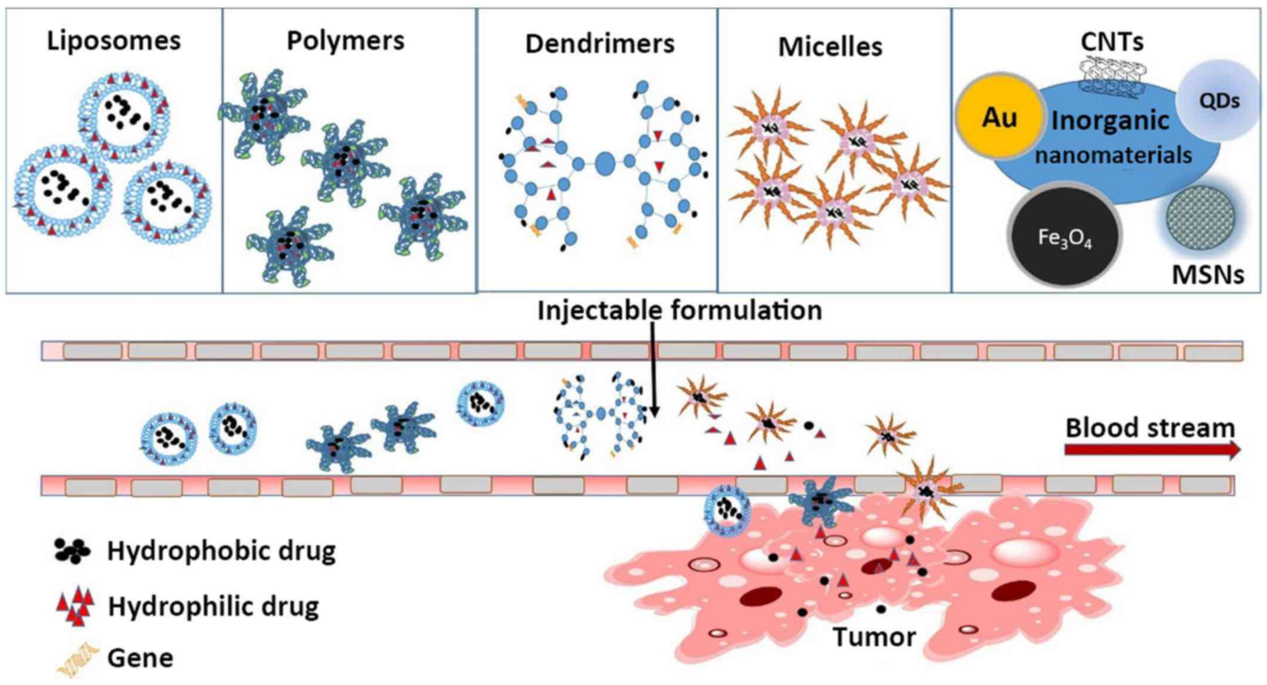




Timeline of the development of nanomedicines

Liposomes, polymeric systems, dendrimers, and PEGylated liposomes were developed as nanodrug carriers in the early phase of discovery. Doxil (doxorubicin) was the first FDA-approved liposome for use in cancer . As nanomedicine developed, the non-PEGylated liposome Myocet (doxorubicin), the albumin-based nanoparticle (NP) Abraxane (doxorubicin), the PEG-PLA polymeric micelle Genexol-PM (paclitaxel), the vincristine sulfate liposome Marqibo, the iron oxide NP NanoTherm, and the targeted ado-trastuzumab emtansine (DM1) liposome Kadcyla have been approved for clinical use. PEG-PLGA polymeric NPs (BIND-014) completed phase II clinical trials in advanced cancers and anti-epidermal growth factor receptor immunoliposomes is in phase II clinical trials recruiting of breast cancer The physical properties of upconversion nanoparticles (UCNPs) used in photodynamic therapy (PDT) also represent a promising direction in future research.

According to the World Health Organization's World Cancer Report 2014, cancer caused 8.2 million deaths worldwide in 2012, and this number is expected to rise to 22 million by 2035. Along with surgery and radiotherapy, chemotherapy is a mainstay of cancer treatment. Chemotherapy is the most frequently used systemic treatment for suppressing cancer cell proliferation, disease progression and metastasis. However, chemotherapeutic drugs not only kill proliferating cancer cells but also inevitably attack normal cells, causing adverse effects. Therefore, antitumor drug vehicles that maintain or improve the efficacy of chemotherapy while reducing the severity of reactions and side effects are urgently needed.



Nanomaterials used as drug carriers for cancer therapy. With their distinct biological characteristics, nanomaterials can improve the enhanced permeability and retention effect, increase bioavailability, reduce the toxicity of chemotherapy drugs, release hydrophobic or hydrophilic chemotherapy drugs into the bloodstream, and achieve cytotoxic effects against cancer cells. CNTs, carbon nanotubes; QDs, quantum dots; MSNs, metal nanoparticles.

Combination therapy with nanoparticle drug carriers, therefore, warrants further study at the preclinical and clinical levels. Other chalenges exist for modified and functionalized nanomaterials with well-established formulations, including improving the localization, biodistribution, biocompatibility, and efficacy of nanodrug systems in vivo, to meet the requirements of precision cancer diagnosis and therapy.

REFERENCES

1. LaVan DA, McGuire T and Langer R: Small-scale systems for in vivo drug delivery. Nat Biotechnol. 21:1184–1191. 2003.
2. Langer R: New methods of drug delivery. Science. 249:1527–1533. 1990.
3. Kamaly N, Xiao Z, Valencia PM, Radovic-Moreno AF and Farokhzad OC: Targeted polymeric therapeutic nanoparticles: Design, development and clinical translation. Chem Soc Rev. 41:2971–3010. 2012.
4. Irvine DJ: Drug delivery: One nanoparticle, one kill. Nat Mater. 10:342–343. 201
5. https://www.innocorepharma.com/nl , (20.08.2021.)
6. Patra, J.K., Das, G., Fraceto, L.F. *et al.* Nano based drug delivery systems: recent developments and future prospects. *J Nanobiotechnol* **16,** 71 (2018). De Jong, W. H., & Borm, P. J. (2008). Drug delivery and nanoparticles:applications and hazards. *International journal of nanomedicine*, *3*(2), 133–149. https://doi.org/10.2147/ijn.s596