



Nanotechnology: An Emerging Science for Cancer Treatment

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Editorial

Cancer is the most serious public health problem in the world and the second leading cause of death. According to the 2020 global cancer incidence study, lung cancer and breast cancer are the most common cancers detected in men and women, accounting for 15.4% and 41.9% respectively of all diagnosed cases globally. Prostate cancer in men and breast cancer in women are the most commonly detected cancer cases, accounting for 26% and 30% of all incident cases involving men and women, in 2021 and 27% and 31% in 2022 respectively. The cause of cancer can be due to various factors like internal stress, environmental influences or hereditary. The cancer-causing factor differs from patient to patient. Cancer caused by infections like Human Papillomavirus (HPV) and hepatitis are responsible for around 30% cancer cases in low and lower middle-income countries. Cervical cancer may become a major concern in females in the near future. It is the most common malignant disorder in females and the fourth leading cause of cancer-related death worldwide accounting for 6.9% of all diagnosed cases as per 2020.

The vaginal microbiota in females is home to a plethora of microbes that help to maintain the host's physiology. *Lactobacillus* sp., including *L. iners*, *L. crispatus*, *L. gasseri*, and *L. jensenii*, protect the vaginal environment by secreting hydrogen peroxide, which maintains the pH of the microbial surroundings, as well as compounds like bacteriocin, which prevents the growth and colonization of harmful microbial strains. Age, menstrual cycle, pregnancy, hormonal imbalance, pH, immune signals, and other factors alter the vaginal microflora. These changes promote the dominance of other harmful anaerobic microbes in the environment, paving the way for female gynecological disorders. Infection with the Human Papillomavirus (HPV) has been found to be the primary cause of over 90% of cervical cancer cases, with HPV 18 and HPV 16 having a very high risk of cancer development, accounting for 70% of cases. HPV inhibits the p53, Rb, and apoptotic pathways of cervical cancer cells. Biofilm formation on the cervical epithelium by harmful gram-negative bacteria prevents antibiotics and clinical therapies from penetrating and acting. They also attract neutrophils, that are linked to reactive oxygen species, which disrupt host tissues. Long-term persistence of HPV and other microbes in these biofilms activates pro-inflammatory cytokinin, tumor necrosis factors, and NF- κ B, resulting in inflammation, tumor growth, and metastasis of the cervical epithelium, ultimately leading to cervical cancer. Other factors that contribute to the progression of cervical cancer after HPV infection include hormonal imbalance, smoking, and Sexually Transmitted Diseases (STI).

The technological revolution has come a long way in overcoming this lethal disease. Nanotechnology, a multidisciplinary field, has demonstrated clinical and therapeutic applications. Nanocarriers have the potential to be used to treat cancer. EPR (Enhanced Permeability and Retention Effect) is used to target tumors with nanoparticulate drug transporters that are highly effective in delivering chemotherapeutics. Because of their small size, nanoparticles are highly traceable and can be used to discover several pathways that can lead to effective cancer treatment mechanisms. Cationic lipid nanoparticles and drug encapsulated in micelles nanomaterials have been identified as the most promising nanoparticle-mediated chemotherapeutics. Polymeric Nanoparticles (PNPs), cationic Lipid Nanoparticles (LNPs), magnetic and gold nanoparticles, cationic lipid-mRNA have been extensively used as a remedy in cancer treatment. The cationic lipid nanoparticles and drug encapsulated micelles, the nanomaterials are found to be the promising treatment for cancer and HPV. Docetaxel with PCL-PLA-TPGS copolymer [poly(ϵ -caprolactone-co-lactide)-D- α -tocopheryl polyethylene glycol succinate], nanoparticles have been found to be highly effective in reducing the

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number of cervical cancer cells. Photodynamic Therapy (PDT) is the new emerging anti-cancer strategies which gained attention in last few years.

Around 30% to 50% cancer can be prevented by avoiding the risk factors. Many cancer cases have high chances of cure if diagnosed with early stages and treated properly. Cancer death rates have been found to be decreasing over the last two decades due to technological advancements such as nanoparticle-mediated drug

delivery. Progress in the field of nanomedical technologies, including the use of niosomes, solid lipid nanoparticles, liposomes, polymeric nanoparticles, metal nanoparticles, natural product-based nano systems, and several other nanoconjugates, have reorganized the drug delivery system, with a focus on cancer drug delivery, as well as the development of new biosensors for the early and simple detection of cancer biomarkers.