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REVIEW ARTICLE Open Access

ROLE OF NANO ENZYME IN DIAGNOSIS, PROGNOSIS AND TREATMENT OF GASTROINTESTINAL TRACT (GIT) CANCER

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Abstract:

Background:

The most common life-threatening problem in population is gastrointestinal tract (GIT) cancer and its mortality rate is very high. Now a days Nanotechnology is a modern way of diagnosis and treatment. Nano-enzymes showed best diagnosis efficacy of treatment and disease progression

Aims and objectives:

The aims and objectives of current review were a comprehensive overview of Nano-enzymes in the diagnosis, prognosis, and treatment of gastrointestinal tract cancer.

Practical Implications:

Through Nano-enzymes different types of cancer may be diagnosis, prognosis, and treated. While the treatment of gastrointestinal tract cancer with Nano-enzymes showed best results. In this review, we outlined the many types of nanoparticles used to treat esophageal cancer.

Conclusion:

A common gastrointestinal cancer with a poor prognosis and a high fatality rate is esophageal cancer. Despite the development of multiple therapy approaches, patients with esophageal cancer still have a low 5-year survival rate. Traditional methods of delivering anti-cancer medications have some drawbacks, including no targeted administration and general toxicity. For the treatment of Esophageal cancer, nanoparticles offer a viable platform for drug delivery since they have a number of outstanding benefits, including less side effects, a longer circulation duration, and a preference for accumulating at the tumor site. These include polymers, micelles, liposomes, inorganic nanoparticles, and organic nanoparticles. In this review, we outlined the many types of nanoparticles used to treat esophageal cancer.

Keywords: Gastrointestinal tract cancer, Nano-enzymes, Diagnosis, prognosis, treatment, Drug delivery, Biosensors, Targeted therapy, Imaging, Biomarkers.

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Introduction:

Recent developments in nanotechnology is a blessing for humanity, there is new hope for disease identification, prevention, and treatment. Specific treatment plans based on the pathophysiology of gastrointestinal problems.[1] In current time the development in the swiftly growing field of nanomedicine is so helpful. The side effects of currently available, otherwise successful treatments are projected to be greatly reduced by the development of nanoparticle vectors capable of delivering medications specifically and only to areas of the gastrointestinal tract affected by disease for an extended period of time.[2, 3] Nanozymes are materials with characteristics resembling those of enzymes. They are the most effective and useful way to link biological systems and nanomaterials.[4]Compared to natural enzymes, Nanozymes have a number of advantages. They are less expensive and recyclable. Nanozymes are relatively simple to make and can be stored for a very long time. Nanomaterials are objects with nanoscale dimensions between 1 and 100 nm, such as semiconductor-based 2D transition metal dichalcogenides, carbon nanotubes, quantum dots, nanowires, and Nano rods formed of inorganic metals.[5] Nanozymes are also distinct from traditional synthetic enzymes in that they contain a variety of functions unrelated to catalysis. At the nanoscale, it is simpler to change and combine materials with huge surface areas.[4]

Nanozymes have several uses in targeted therapy, biosensing, and diagnostic medicine. The ability to recognize disease in its early stages is particularly important for improving clinical outcomes. The creation of rapid, trustworthy, and extremely sensitive biosensors using Nanozymes.[6] Additionally, Nano-enzymes may make up for the shortcomings of natural enzymes, such as their rapid inactivation, high cost, and low yield. [7]The gastrointestinal tract (GIT) cancer is one of the most prevalent types of cancer and a major cause of death in the globe. The digestive system, which includes the esophagus, stomach, pancreas, liver, and colon, is affected by GIT cancer.[8] Horseradish peroxidases and other naturally occurring enzymes were employed in bioassays in earlier methods of illness diagnosis employing biosensing technologies. The enzymes are used to catalyze colorimetric activities when the target molecules are present. By using Nanozymes that mimic the catalytic properties of natural enzymes, biosensors can be produced more quickly and economically.[9]

The GI tract is a desirable target system for nanotechnology applications, It is the site of therapeutic absorption, and under different pH, transit time, pressure, and bacterial content circumstances, the behavior of humans with gastrointestinal tract (GIT) cancer can be controlled during transit through the digestive tract analysis.[10] According to the World Health Organization (WHO), cancer is one of the dangerous diseases that accounts for 7.9 million global fatalities, or a mortality rate of 15%. Within the following ten years, 16.2 million more fatalities are anticipated. Nano systems have been extensively studied for their potential in biomedicine, particularly in the treatment, diagnosis, and imaging of cancer.[11] The science and technology known as nanotechnology is concerned with precisely controlling a material's molecular structure. The application and manipulation of materials are on a small scale. When molecules and atoms are small, they behave differently, giving rise to a number of intriguing applications.[12] The National Cancer Institute recognized the phrase cancer nanotechnology, and believes that nanotechnology has an amazing, paradigm-shifting chance to significantly advance cancer diagnostics and treatment.[13]

From 11 to 110 nm, nanoparticles are solid, distinct particles or dispersions. Polymeric magnetic and micelles nanoparticles, colloidal gold nanoparticles, and ceramic nanoparticles are being researched for application in drug delivery systems. These nanoparticle-based drug delivery systems can be coated to target tumour cells with substances such as tumor-specific antibodies, peptides, sugars, hormones, and anti-carcinogenic drugs.[14] Drug delivery methods should use nanoparticles that are both big enough to prevent fast leakage into blood capillaries and small enough to avoid being ingested by macrophages found in organs with reticuloendothelial systems, such the liver and spleen.[15] According to the definition, nanostructures are geometrical arrangements that range in size from 1 to 100 nm. Different sizes Nanoparticles have various biomedical applications. Nano systems have been extensively studied for their potential in biomedicine, particularly in the treatment, diagnosis, and imaging of Gastrointestinal Tract cancer.[16]

The science and technology known as nanotechnology is concerned with precisely controlling a material's molecular structure.[14] The application and manipulation of materials are on a small scale. Smaller molecules and atoms behave differently, which opens up a wide range of intriguing uses. [17]The National Cancer Institute recognized the phrase "cancer nanotechnology" and believes that it presents an unprecedented, paradigm-shifting chance to achieve significant advancements in cancer diagnostics and therapy.[18] Nanoparticles -coated capsules can prevent the degradation of pharmaceuticals. Due of its small size, Nanoparticles are easily broken into smaller capillaries and taken up by cancer cells.[19] As a result, medicines can be effectively absorbed at the target spot. The ability of nanoscale systems to effectively circumvent kidney clearance and, as a result, give medications they carry adequate blood circulation time is another benefit.[20]

The use of unique, effectively organized nanoparticles with the potential to improve performance in the detection, diagnosis, and treatment of GIT cancer and other types of tumors has been made possible by the use of nanotechnology.[17] Cancer incidence and mortality rates have recently been rising quickly, yet conventional cancer treatments, such as surgical removal, radiotherapy, chemotherapy, and targeted therapy, typically have lengthy treatment durations, a high recurrence rate, and a number of adverse effects.[21] Because of this, we attempt in this review to succinctly and timely summaries the most current developments in the treatment of cancer based on enzyme-driven micro/nanometers, including brain tumors, bladder cancer, breast cancer, and others.[22] Increased knowledge of potential cancer warning signs among medical professionals, other healthcare workers, and the general population can be extremely beneficial. A crucial first step in treating cancer is cancer diagnosis during the early stages of carcinogenesis. It has been significantly successful in lowering cancer brought on by viruses like the human papillomavirus.[23]

This Review focuses on advances in Enzymology role of nano enzyme in diagnosis, prognosis and treatment of gastrointestinal tract (git) cancer which will bring awareness in the field of Biomedical Science and will make GIT cancer sense, knowledge and precautionary measures more common in non-Medical persons and will bring a change of betterment in the Community.

Study Gap:

No practical study data was collected all published statistical analysis and previous and new findings were considered to compile up a dramatic literature in the field of Enzymology and Nanotechnology regarding Gastrointestinal Tract Cancer.

GIT Cancer types and involvement of Nano Enzymes:

The esophagus, stomach, bile duct, gallbladder, and pancreas are just a few of the organs that make up the upper digestive tract. One of the top causes of cancer-related deaths worldwide is upper gastrointestinal (GI) cancer. [24]There are number of GIT cancers types each has different indications and treatment options. The common types of GIT cancers found in population are the following:

Esophageal cancer:

Esophageal cancer is a condition in which the tissues of the esophagus develop malignant cells. Smoking, binge drinking, and Barrett esophagus can all raise your risk of developing esophageal cancer. [25]Weight loss and uncomfortable or difficult swallowing are indicators and symptoms of esophageal cancer. Nano-enzymes treatment used for esophageal cancer, through this technology with the help of different biomarkers the spread of disease can control.[26]

Gastric cancer:

When cells in any area of the stomach multiply and divide in an uncontrolled manner, Gastric cancer occurs.[27] While tumors can start anywhere in the stomach, the majority do so in the glandular tissue on the inner surface of the stomach. Stomach adenocarcinoma is this sort of cancer the negative effects of conventional chemotherapy can be reduced by using Nano-enzymes to guide chemotherapy medications directly to the cancer cells.

Pancreatic cancer:

The pancreatic ducts are where pancreatic cancer generally begins. Small alterations in cellular DNA cause uncontrolled cell proliferation and an accumulation of cells in masses known as tumors. These cancer cells may invade organs other than the pancreas if left untreated. [28]This field deals with the use of nanoparticle technology for medicinal purposes. These technologies have a long and active history of development across numerous disease situations. Recently, the SARS-CoV-2 pandemic has been included in this, and nanoparticles have received considerable acclaim for their essential role in vaccine development.[29]

Liver cancer:

Hepatic carcinoma refers to cancer that begins in the cells of the liver. The liver, a football-sized organ, resides in the right upper belly, above the stomach and below the diaphragm. Several types of cancer may manifest in the liver.[30] Most cases of liver cancer begin in hepatocellular cells, the liver's most common cell type. Liver cancers like hepatoblastoma and intrahepatic cholangiocarcinoma are very rare. In order to detect and track specific biomarkers for liver cancer, nano-enzymes may be used as biosensors.[31]

Colorectal cancer:

Cancer of the colon or rectum is called colorectal cancer. Depending on the site of early manifestation, these cancers may be called colon or rectal cancer. [32]Rectal and colon cancer are often confused with one another because of their similarities. Nano-enzymes may be used as drug delivery systems in targeted treatment to ensure that chemotherapeutic drugs reach cancer cells while sparing healthy tissue as much as possible.[33]

Nanotechnology and Cancer:

Due to the minimal risk of negative side effects, microscopic size, and controlled medication release, research in nanomedicine and nanotechnology has been hailed as motivation for the creation of innovative therapeutic processes on a Nano scale.[34] To that end, scientists have been researching and developing nanoscale tools, technologies, and medication delivery systems under the umbrella term "nanomedicine." Nanotechnology has the potential to improve cancer detection outcomes via the more efficient use of innovative screening methods.[35] Unique physicochemical qualities include ultra-small and controlled size, a high surface area to mass ratio, and a functionalized structure.[36] Because of their profound effects on pharmacokinetics, bio-distribution, and safety, particle size and size distribution are among the most acknowledged distinguishing aspects of nanoparticle-based therapeutics.[37, 38]

Table-1: Types of GIT cancers, symptoms and treatment options available

Type of cancer	Locations	Sign & symptoms	Treatment available
Esophageal	Esophagus	Difficulty in swallowing, chest pain, weight loss	Surgery, radiation therapy, chemotherapy, targeted therapy
Gastric	Stomach	Indigestion, stomach pain, nausea, vomiting, weight loss	Surgery, chemotherapy, radiation therapy, targeted therapy
Colorectal	Colon or rectum	blood in the stool, Changes in bowel habits, abdominal pain, unexplained weight loss	Surgery, chemotherapy, radiation therapy, targeted therapy
Pancreatic	Pancreas	jaundice, digestive problems	Surgery, chemotherapy, radiation therapy, targeted therapy
Liver	Liver	Abdominal pain, nausea,	Surgery, chemotherapy, radiation therapy, targeted therapy
Anal	Anus	itching, discharge	Surgery, radiation therapy, chemotherapy
Gallbladder	Gallbladder	vomiting, jaundice	Surgery, chemotherapy, radiation therapy
Small intestine	Small intestine	digestive problems	Surgery, chemotherapy, radiation therapy, targeted therapy

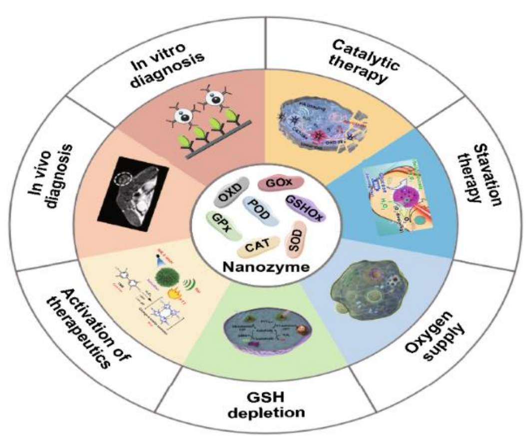

Fig-1: Graphical presentation of gastrointestinal cancer and Nanoenzymes

Traditional Diagnostic Methods for GIT Cancer:

Imaging tests:

Fine features of interior organs are captured by sophisticated imaging procedures like CT, MRI, or PET scans. [39]These images assist doctors confirm or rule out cancer by displaying the precise location of a tumour. Additionally, your doctor could advise imaging studies to find out if and where cancer cells have spread.[40]

Blood tests: Tumour markers are chemicals produced by cancer cells. Tumour marker blood tests can aid in the diagnosis of GI cancer.[2] Blood tests can also help physicians better understand your condition or the operation of your organs, which can reveal if cancer has spread or not.[41]

Barium swallow:

You consume a particular beverage for this radiological exam, and then you undergo X-rays. The barium in the beverage makes the top portion of the digestive tract easier for doctors to view on X-rays.[42]

Endoscopy:

A doctor performs an endoscopic procedure on you in which they pass a small, flexible tube with a camera at the tip down your throat. This technique can assist our staff in assessing the stomach and oesophagus as well as the upper digestive system. In conjunction with tissue removal, doctors may examine cells for indications of malignancy.[42]

Colonoscopy:

The rectum is carefully examined by a clinician using a flexible device connected to a camera (colonoscope).

[43]This treatment may be used by doctors to examine the colon and rectum, which are among the lower digestive organs. During the surgery, your doctor may remove any abnormal tissue or polyps if they notice a problem region. Study up on colonoscopy.[44]

Endoscopic ultrasound (EUS):

A minimally invasive treatment called an endoscopic ultrasonography uses sound waves to create images of interior organs including the pancreas and digestive tract.[41]

Biopsy:

In Biopsy method an endoscope is a device that a gastroenterologist or surgeon uses to take a tiny sample of tissue from the afflicted region during this treatment. Then, using a microscope, our committed GI cancer pathologists search for distinctive cancer cell patterns.[44]

Advancements in Diagnosis of GIT cancer with Nanoenzymes:

Nanotechnology allows for tests to be conducted concurrently on a large number of targets, with high levels of selectivity and sensitivity.[45] Biosensors may be better able to give targeted detection if they include nanomaterials (substances having at least one internal or external structure on the nanoscale dimension) and nanoparticles (NPs), which are nano-objects with three outer nanoscale dimensions.[46] Biosensors' sensitivity to biomolecular diagnostics is improved by NPs' high surface-to-volume ratio. Because of this characteristic, NP surfaces may be coated with a broad variety of molecules, including antibodies, small molecules, peptides, aptamers, and DNAzymes.[47] These compounds have been shown to detect and bind to certain cancer-causing chemicals. Increasing the specificity and sensitivity of a test may be possible by the introduction of several binding ligands to cancer cells.[48] **- Diagnosis of GIT Cancer with nano enzymes:**

In the commercial, academic, and green synthesis arenas of activity, biocatalysts has emerged as a crucial element of contemporary organic synthesis. Its success can be largely credited to the development of cutting-edge techniques for the identification of novel enzymes and the use of a high-throughput laboratory.[49] Different enzyme expression patterns can be seen in tumor tissue, which is helpful for developing efficient enzyme-responsive Nano-drug delivery systems. One method to induce a medicine to accumulate in tumors is to design a stimulus-responsive mechanism that can only distribute the potential drug in the tumor microenvironment (TME)[50]

Table 2: GIT Cancer Nano Enzymes Diagnostic Methods[46, 47]

Diagnostic Technique	Procedure	Nano Enzymes Used	Applications	Gastrointestinal Tract Cancers Diagnosed
Colorimetric Assays	1. Immobilization of nano enzymes on a solid support	Horseradish peroxidase (HRP)	Detection of specific cancer biomarkers	Colorectal cancer, gastric cancer
	2. Incubation with patient sample containing biomarkers			
	3. Color development due to enzymatic reaction			
Electrochemical Biosensors	1. Functionalization of electrode surface with nano enzymes	Glucose oxidase (GOx)	Detection of cancer biomarkers using electrical signal	Gastric cancer
	2. Exposure of the modified electrode to patient sample			
	3. Measurement of electrochemical response			
Imaging and Detection Methods	1. Administration of nano enzyme-based contrast agents	Catalase, peroxidase, glucose oxidase (GOx)	Visualization of tumor sites	Colorectal cancer, pancreatic cancer, gastric cancer
Magnetic Resonance Imaging (MRI)	1. Administration of nano enzyme-based contrast agents	Various types of nano enzymes	Non-invasive imaging for tumor localization and characterization	Colorectal cancer, pancreatic cancer, gastric cancer

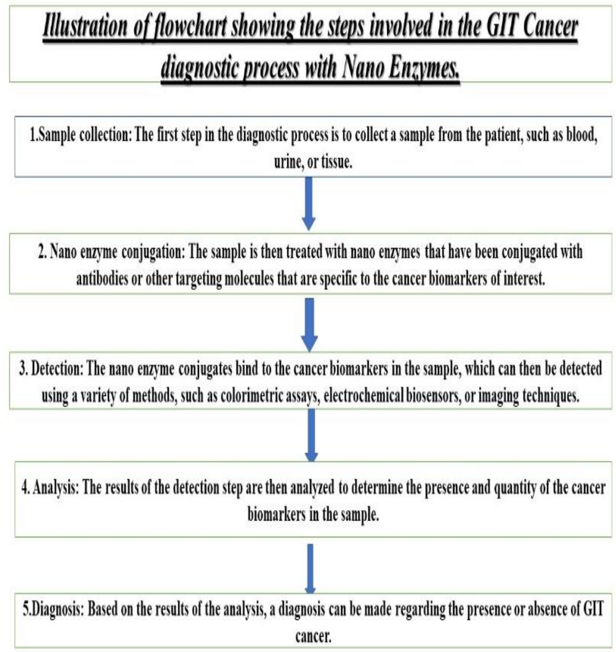

Fig-2: Illustration of flowchart showing the steps involved in the

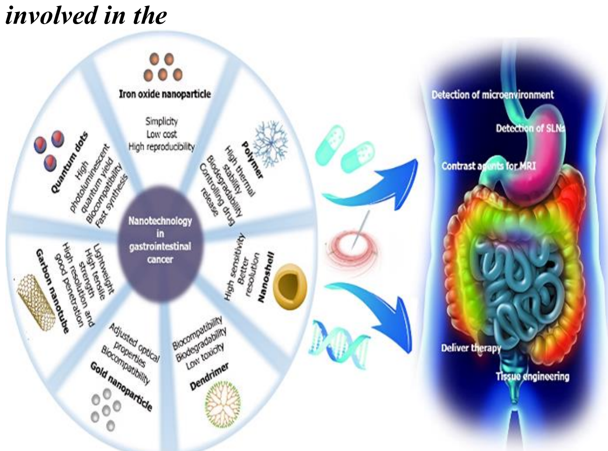

Fig-3: Nanodevices for the detection and treatment of cancer of the gastrointestinal tract

GIT Cancer diagnostic process with Nano Enzymes

Nanotechnologies, which have excellent sensitivity, specificity, and permeability, have mostly been used in MRI-based clinical applications for tumor detection and GI tract imaging. [51]Future medical treatments must incorporate nanotechnology-based medication delivery, notably for the treatment of cancer. [52]Nanomaterials exhibit remarkable use for enhancing therapeutic effectiveness because of their high biocompatibility. To accomplish precise targeting and regulated medication release, many Nano Particles have the capacity to carry a variety of drug.[53]

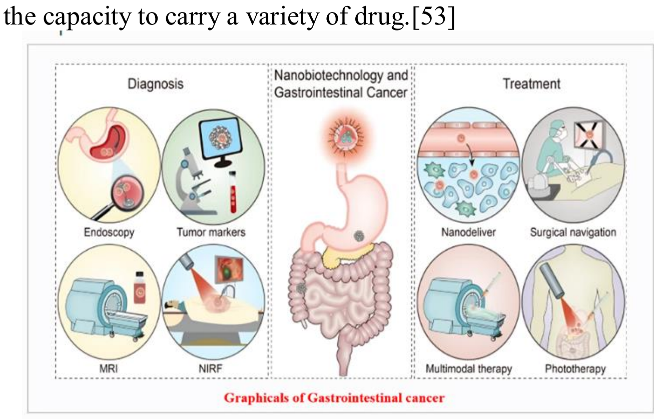

Fig-4: Schematic illustration indicating the applications of Nanozymes in cancer diagnosis in vitro

Prognosis of gastrointestinal through nanotechnology:

Cancer management includes the prediction of a disease's outcome or course, which is known as prognosis. Early prognosis in the case of gastrointestinal (GIT) cancer is essential for choosing the best course of action and enhancing patient outcomes. [54]The prognosis of GIT has showed promise when using nanotechnology and Nano-enzymes. Nanotechnology has opened up new possibilities for the diagnosis and treatment of cancer.[55] Combining nanoparticle-based technology with imaging enhances targeted drug delivery, lessens adverse effects, and refines the accuracy of tumour detection.[56] Improved detection specificity, reduced medication toxicity, enhanced impact of contrast agents, and more effective diagnosis and treatment of gastrointestinal (GI) cancers are just a few examples of the many domains where optimized Nano systems have proven useful. [3, 57]

Nano enzymes can also be used in cancer prognosis to predict the likelihood of disease progression and patient survival. [58]Nano enzymes can be developed to target certain indicators that indicate a tumor's aggressiveness, such as the expression of specific enzymes or receptors. For instance, nanozymes can be developed to precisely target the enzyme telomerase, which is elevated in a number of malignancies, including GIT cancer, and is linked to a bad prognosis.[59] Nanozyme-based prognostic assays have been created for the detection of telomerase in cancer patients, and they are quite effective in predicting patient survival.[60, 61]

Cancer management includes the prediction of a disease's fate or course, which is known as prognosis. Early prognosis in the case of gastrointestinal (GIT) cancer is essential for choosing the best course of action and enhancing patient outcomes. The use of nanotechnology and nano-enzymes to improve GIT cancer prognosis has showed promise.[62]

The most typical malignancy with a dismal prognosis is gastrointestinal Tract cancer (GIT). Currently, the primary form of therapy for GIT cancer is surgery. However, the low five-year survival rate is a result of the high postoperative recurrence rate. Immunotherapy has gotten a lot of attention recently.[63] Immune checkpoint blockade (ICB) therapies are the only immunotherapy medications recognized by the Food and Drug Administration (FDA) and show significant potential for cancer treatment. Nevertheless, the poor immunogenicity and immunosuppressive milieu of GIT cancer severely restrict the efficacy of ICB therapy.[64]

Therefore, the goals of immunotherapy have changed from ICB to enhancing tumour immunogenicity, boosting immune cell recruitment and maturation, and decreasing the number of immune cells that are inhibitory, such as regulatory T cells, myeloid-derived suppressor cells, and macrophages that look like M2 cells.[65] Novel nanodrug delivery methods have also been a research focus for anticancer therapy due to the advancement of nanotechnology and the FDA's approval of a number of nanoparticles for clinical therapy.[66]

GIT Cancer Stages and Prognosis rate:

Stages of stomach cancer survival are listed here. Survival data is available globally for each stage of stomach cancer. [67]These statistics for those diagnosed between 2013 and 2017 were compiled from several literary research.[68, 69]

Stage 1 Patients with stage 1 stomach cancer had a 65% chance of becoming cancer-free after 5 years.[70]

Stage 2 Approximately 35% of those diagnosed with stage 2 stomach cancer will be cancer-free at least 5 years after their diagnosis.[71]

Stage 3 Patients diagnosed with stage 3 stomach cancer have a survival rate of around 25% after five years.[72]

Stage 4 Stage 4 cancer survival rates after 5 years are not available. This is because, sadly, most patients end up dying soon after being diagnosed. [73]The Office of Vital Statistics does provide information on the 1-year survival rates of patients with stage 4 stomach cancer. About 20 out of every 100 people diagnosed with stage 4 stomach cancer will be cancer-free after a year.[74]

Nano Enzymes in GIT Cancer Treatment:

Drug delivery is greatly impacted by the interaction of nanoparticles with proteins and the development of protein corona in biological fluids.[75] Corona formation in the blood and its effects on the in vitro and in vivo fate of nanoparticles have been thoroughly examined and reviewed during the past ten years.[23] Recently, the interactions between the digestive enzymes and the orally delivered nanoparticles that occur in the gastrointestinal tract (GIT) are receiving an increasing amount of attention.[76] The characteristics, gastrointestinal transit, and oral absorption of nanoparticles can all be strongly impacted by the enzyme corona produced in the GIT. Because oral delivery is the most popular delivery method, it is crucial to fully comprehend how the GIT's corona development affects oral delivery nanoparticles.[77]

Nanomaterials are used in Nano biotechnology for a variety of purposes, including diagnosis, drug delivery, prosthetics, and implants.[78] Due to the fact that the majority of biological systems are nanoscale, nanoscale materials integrate well into biomedical equipment. Nanozymes are synthetic enzymes made from nanomaterials.[79] Ions and molecules can be detected using nanozymes. Both qualitatively and quantitatively, as well as organic molecules. Additionally, they have been used for the eradication of microorganisms that are resistant to many medications and the breakdown of various organic contaminants.[80]

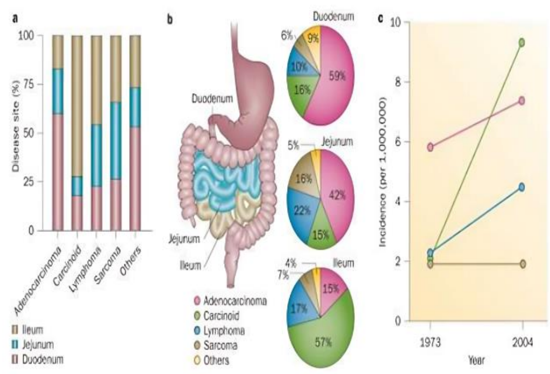

Fig 5: Localization of Small Bowel Cancer

Nanotechnology has emerged as a promising area for fighting cancer. Cancer nanotechnology is the creation and application of nanoscale nanomaterials, such as nanoparticles or Nano enzymes, for the treatment of cancer.[81] The leading cause of cancer-related fatalities globally is colorectal cancer, often known as big bowel cancer. Practical and precise Nano enzymes with anticancer bioactive properties that may originate from a variety of highly expressed receptors on the surface of tumor cells.[82] Nano enzymes lessen the negative consequences of cancer and aid in early diagnosis, lowering the death rate. Numerous benign polyps have been found in the colon at various locations, however their early detection prevents them from turning cancerous. Cancer therapeutics benefit from Nano enzymes.[83, 84]

Nano Enzymes in GIT Cancer Treatment:

A promising strategy for the treatment of several types of cancer, such as gastric cancer, pancreatic cancer, and colorectal cancer, is being explored in the newly-emerging field of research known as GIT cancer treatment using Nano enzymes.[20]

Chemotherapy: The medical community routinely employs the usage of chemotherapy. Chemotherapy has tremendous therapeutic promise, but cancer's heterogeneity, multidrug resistance, and nonspecific drug distribution severely limit its usefulness.[85] Therefore, a trend in modern clinical research is to use chemotherapy in conjunction with nanotechnology. This treatment may greatly enhance therapeutic efficacy with minimal side effects on healthy tissues.[86, 87]

Photodynamic therapy: Light is a potent tool that has been used for ages to treat a wide variety of medical conditions.[88] It was utilized as a skin treatment in ancient Egypt, India, and China. Photochemotherapy is also a well-established therapeutic option.[89]

Radiotherapy: Treatment for lung cancer often includes radiation therapy. Radiation therapy is generally under utilized, despite having a strong evidence foundation for treatment in 77% of all patients with lung cancer.[90] At any point in the disease's progression, radiotherapy may be employed either as a curative or palliative treatment.[91] In recent years, advancements in technology have allowed for more precise cancer targeting during radiotherapy, while also reducing the amount of radiation that accidentally reaches healthy tissue.[92]

Immunotherapy: The use of the patient's own immune system to combat cancer has recently emerged as a viable therapeutic option.[93] This treatment not only kills cancer cells, but also stops them from coming back by triggering a robust immune response. Some of the persistent problems with therapeutic cancer immunotherapy include off-target effects, inefficient transport of cancer antigens to immune cells, and significant immune-mediated toxicity.[94]

Gene therapy: Although gene therapy's potential has been a boon to the development of novel ways for combating cancer's spread, clinical effectiveness has not yet caught up to the level necessary to fully fulfil gene therapy's promise.[95] Gene silence, antisense treatment, RNA interference, and gene and genome editing are just a few examples of the many available approaches to gene modulation; yet, targeting specific cells at certain times has proven difficult.[96] In order to get around this problem, nanomedicine has provided a wide range of novel platforms. Most of these systems cannot function without the incorporation of nanoscale objects, and nanoparticles in particular.[97]

Photo thermal immunotherapy: In addition to removing the original tumours, an effective tumour treatment approach also involves stimulating the host immune system and eliminating any metastatic or residual tumour cells.[98] It is prudent to combine local treatment with immunotherapy so as to maximize the therapeutic impact and make the most of the benefits offered by immunotherapy.[99]

Nanoparticle-based drug delivery: Nanomedicine and nano delivery systems are an emerging and quickly evolving discipline in which nanoscale materials are used for diagnosis or for the controlled administration of therapeutic chemicals to specific sites.[99] Nanotechnology's ability to target medication delivery to specific organs and tissues has significant implications for the treatment of chronic human diseases. Nanomedicine has been put to incredible use recently in the treatment of a broad variety of diseases. [39]

Magnetic targeting: Magnetic nanoparticles loaded with drugs may be targeted to the tumour location with the help of an external magnetic field. This approach has the potential to improve medication delivery and accumulation at the tumour site while reducing systemic toxicity.[56, 100]

Thermal ablation: Gold nanoparticles may be targeted to tumour cells via a variety of methods, such as antibody or peptide coupling.[5] When subjected to an external laser or magnetic field, the gold nanoparticles may heat up and destroy cancer cells. Potentially very selective, efficient, and sparing of healthy tissue is this approach.[101, 102]

Photo-thermal immunotherapy: Tumour metastases are responsible for around 90% of all fatalities caused by cancer.[103] The diagnosis of cancer often came too late for many individuals who had already developed metastases. More than 80% of people with lung cancer are found to have metastatic illness.[104]

Enzyme prodrug therapy: The utilization of enzyme/prodrug systems has garnered interest as a means to improve the efficacy and safety of standard cancer chemotherapies.[105] First, cancer cells get a gene transfected into them that expresses an enzyme that can transform a non-toxic prodrug into its active cytotoxic form. Therefore, the active prodrug may be able to destroy the transfected cancer cells.[106] Despite significant progress in preclinical research and early clinical trials, no suicide gene therapy approaches have made it to the clinic for a variety of reasons**.** [107]

Discussion:

Since this work is still in its infancy, comparing the effectiveness of different nanoparticle platforms from different labs is now impossible, making it challenging to standardize the therapy.[108] The clinical development of this therapy may be sped up by standardizing treatment parameters such nanoparticle kind, tumour type, and laser intensity.[109] Nanoparticles have been shown to have a profound effect on the tumour microenvironment.[110] It's well knowledge that photothermal treatment may enhance local tumour temperatures, which in turn helps reduce hypoxia in the tumour microenvironment and boosts blood flow inside the tumour itself.[111] Recent research has shown that combining photothermal therapy with either photodynamic therapy or radiation therapy effectively decreases hypoxia in the tumour, increasing the synergistic advantages of the combined treatments.[112, 113]

Over the past 20 years, substantial preclinical research has been done on gene-directed enzyme prodrug treatment for cancer.[114] Numerous clinical trials have been conducted using the preclinical data as the foundation.[47] Despite significant advancements, no gene treatment for cancer suicide has received clinical approval. The second flaw in this method is that the enzyme is derived from plants, which leads to an indeterminate collection of isoenzymes with various glycosylation patterns that may have negative physiological effects.[50, 115]Because of their unfavorable side effects, invasiveness, and inability to effectively treat advanced stages of the disease, standard esophageal cancer detection and treatments are only partially effective.[116] Furthermore, the current white light endoscopy cannot detect early esophageal cancer. It is therefore vital to look for alternate diagnostic and therapeutic approaches.[117] Early discovery is essential for a cancer's best prognosis since it allows for quicker treatment, increases survival rates, and prevents the disease from spreading.[118]

In a recent study, fluoroscopy-assisted photodynamic therapy in conjunction with nanoparticle albumin-bound paclitaxel was shown to provide outstanding therapeutic outcomes in patients with locally advanced esophageal cancer by eliminating the tumor mass while preserving the organ intact and functioning. Liu et al.[119] have created and synthesized a nanozyme system based on carbon Nano cages to battle tumour hypoxia and improve the detection, diagnosis, and therapy of esophageal cancer.[76, 120] Although NPs' biocompatibility may be improved by surface attachment, any adverse consequences should be carefully considered.[121] It is critical to do more clinical research on the aforementioned overview of targeted photodynamic diagnostics and photodynamic therapy treatment for esophageal cancer, as well as the role of functionalized nanomedicine, in order to assist clinical translation.[122]

Further Study and Research is needed in the field of Nanotechnology and Gastrointestinal Tract Cancer this will bring a revolution in the field of Biomedical Science.

Conclusion:

A common gastrointestinal cancer with a poor prognosis and a high fatality rate is esophageal cancer. Despite the development of multiple therapy approaches, patients with esophageal cancer still have a low 5-year survival rate. Traditional methods of delivering anti-cancer medications have some drawbacks, including no targeted administration and general toxicity. For the treatment of Esophageal cancer, nanoparticles offer a viable platform for drug delivery since they have a number of outstanding benefits, including less side effects, a longer circulation duration, and a preference for accumulating at the tumor site. These include polymers, micelles, liposomes, inorganic nanoparticles, and organic nanoparticles. In this review, we outlined the many types of nanoparticles used to treat esophageal cancer.

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