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Review Article

Review On : Advancement In Anticancer Drug Development

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ABSTRACT

Recent years have witnessed an impressive progress in the treatment of malignancies with the use of anticancer drugs which are much more selective than the commonly used chemotherapy agents. Highlights include targeted therapy like tyrosine kinase inhibitors which targets specific molecular link to tumor growth and immunotherapy like immune checkpoint inhibitors and CAR T-cell therapies that use the body's own immune system against cancer. Precision medicine based on biomarkers offers a possibility to deliver a certain therapy depending on the genetic predisposition of a patient, and new approaches in drug delivery, such as nanotechnology, improve the efficiency of treatments and diminish the adverse effects. New knowledge of the cancer drug resistance factors prompted the development of its successors and combinations, providing approaches to fight this disease's shift. Also, the present revolutionary technologies like gene editing-CRISPR and the AI-driven drug discovery converge into the future thematic area of cancer treatment. However, alongside these advancements there are issues like resistance, side effects and affordability and therefore there still is significant research needing to be done in order to enhance the patients' quality of life.

INTRODUCTION

Yet cancer stays amongst the leading diseases that cause death globally, calling for immediate search for better and less destructive therapies. Traditionally, anticancer drugs were just chemotherapeutic agents that deal a blow on all dividing cells with catastrophic harm to normal cells on the sideline. But in the last several decades research in cancer has come up with target therapy, immunotherapy, precision medicine, and new drug delivery systems. These innovations make treatment more efficient, and patients' quality of life is better, while the side effects of treatment are reduced. Cancer is an undesirable disease in which cells begin to divide rapidly forming tissues growths that have an abnormal tissue structure and can extend their functioning to other organs/tissues or other vital systems of the body in a way that hampers their operation. Multifactorial disease,

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see, is one that is caused by various determinant agents and these are accurately known to cause cancer through Genetic mutations, pollution, food contaminants, viruses, Chemicals along with Ionizing Radiation. At least five evolutionarily conserved cell cycle control systems ensure proper cell division to produce two daughter cells which are identical. Cancer is one of those diseases that have recently been making a large number of fatalities. Proper management of this disease has however been compounded by the differences around this disease all over the world, the effects of the medical facilities that are available and other socio-economic factors. The global cancer statistics are as follows 2023, 20 million more will be affected than cancer and 10 million people will die due to cancer. It is projected that within the next two decades, all regions of the world will experience a similar cancer incidence burden increase by about 60% consistent with populations and society but in contrast to health systems and communities. A cross-sectional study reviewed research survey data conducted in Ethiopia between 2000 and 2016 revealed that cancer killed an estimated number of 50,913.5 (95%) of people of all ages and both genders and with a crude death rate of 49.7/100000 and an age standardized death rate of 93.5/100000 of which the majority of the cancer patients were females. This is because the life expectancies have risen and so too has the number of cancer occurrences to uncharted heights. Thus, the pharmaceutical industry has greatly funding this therapeutic area. Nevertheless, the attempts to improve the situation remain unconvincing because the field of cancer drug research remains remarkably challenging, and the therapeutic progress does not bring about the expected clinical impact. However, starting from the first half of the twentieth century, drug manufacturers began to produce medicines with even a high cost-benefit ratio by using new knowledge of the disease's physiopathology. Currently, drug companies have developed several anticancer drug types, including cytotoxic drugs, hormones and hormone antagonists, and immunomodulators. Chemists in the drug industries have developed several kinds of anticancer drugs, including cytotoxic drugs which include, alkylating agents, antimetabolites, antibiotics, plant extracts and other cytotoxic drugs, hormones and hormone antagonists, immunomodulators. However, problems remain with these chemotherapies includ- ing nonspecificity, toxicity, the development of multi-drug resistance, and proliferation of stem-like cells.10;101 The discovery of new molecular targets has revitalized the search for better therapies. The two key challenges affecting cancer drugs targeted a clinical use, namely drug selectivity enhancing and reducing the side effects have been answered by monoclonal antibodies and antibody small molecule conjugates. Manufacturers and researchers have published a ton of literature on drug targets and new drug development strategies by taking into account the difficulties of anticancer drugs, their toxicity profiles, non-selectivity characteristics, and related side effects. This review therefore aims to compile and summarize a collection of publications centered on novel chemical compounds with cytotoxic activity on cancer cells in vitro, or both, in particular novel biomarkers and target proteins with potential therapeutic properties

Searching strategy

From March 20 to May 12, previous study data on the discovery of anticancer drugs was gathered from journals using PubMed Central, Google Scholar, and Science Direct. To make it simple for referencing, literature was accurately retrieved, sorted out based on the topic's proximity and the publication date, and then directly cited from the publications

MATERIALS AND METHODS

In this review, the reviewer employs webistes like the google.Scholar, PubMed Central, and Science Direct as sources of search ,The distinct tools can be connected to a personal computer and other accessories.

Searching results

The articles and book chapters identified through searching and filtering of the databases, only those published during the last five years were selected.through the above strategies, I discovered that majority of the articles , concerning the last scientific breakthroughs in the field of anticancer drug discovery. These findings are grouped into three major categories: anticancer drug targets and biomarkers; in vitro and in vivo trials on newly cytotoxic drug advances; and plant-derived advances. Additionally, advances in drug repurposing are included. Furthermore, studies on drug repurposing are added, including those involving approved, discontinued, and shelved medications with anticancer activity. Additionally, studies on electrochemotherapy, gene therapy, phytomedicine, and immunotherapy are included

General Overview of Anticancer Drug Discovery

Anticancer drug discovery is a dynamic and multidisciplinary field aimed at developing therapeutic agents to prevent, diagnose, and treat cancer. The process involves identifying promising compounds, understanding cancer biology, and translating these findings into effective treatments. Here's an overview of the major stages and approaches involved:

Cancer Biology and Target Identification

Understanding the underlying biology of cancer is the first step in anticancer drug discovery. Cancer is driven by genetic and epigenetic alterations that lead to uncontrolled cell growth, invasion, and metastasis. Identifying critical molecular targets (e.g., oncogenes, tumor suppressors, signaling pathways) is crucial for developing drugs that specifically target these mechanisms.

Examples of key targets include:

HER2: Overexpressed in some breast cancers.

EGFR: Mutations in non-small cell lung cancer.

BRAF: Mutations in melanoma.

PD-1/PD-L1: Immune checkpoint molecules involved in immune evasion by tumors.

High-Throughput Screening (HTS)

After identifying a target, libraries of chemical compounds are screened to find molecules that interact with the target. High-Throughput Screening (HTS) allows rapid testing of thousands to millions of compounds for biological activity. These compounds are typically small molecules, but biologics (such as antibodies) are also common in modern drug discovery.

Lead Optimization

Once a lead compound is identified, it undergoes a series of chemical modifications to improve its efficacy, selectivity, pharmacokinetic properties (absorption, distribution, metabolism, and excretion), and safety. Medicinal chemists focus on structure-activity relationship (SAR) studies to enhance these properties.

Preclinical Development

Lead compounds that show promise in vitro (in cell cultures) are then tested in animal models to assess their efficacy, toxicity, pharmacokinetics, and pharmacodynamics. This stage helps in understanding the drug's mechanism of action, its potential side effects, and dosing regimens before moving to human trials.

Clinical Trials

Clinical trials are conducted in several phases to test the drug's safety and efficacy in humans:

Phase I:

Tests for safety, dosage, and side effects in a small group of healthy volunteers or patients.

Phase II:

Focuses on the drug’s effectiveness in a larger group of patients and further evaluates safety.

Phase III:

Involves large-scale testing in diverse patient populations to confirm the drug's efficacy and monitor adverse reactions.

Phase IV:

Post-marketing studies are conducted to gather more information about the drug's long-term risks, benefits, and optimal use.

Types of Anticancer Drugs

Cytotoxic agents:

Traditional chemotherapy drugs, such as alkylating agents (e.g., cisplatin) and antimetabolites (e.g., methotrexate), kill rapidly dividing cells but affect both cancerous and healthy cells, leading to significant side effects.

Targeted therapies: Designed to interfere with specific molecules involved in cancer growth. Examples include tyrosine kinase inhibitors like imatinib for chronic myeloid leukemia (CML) and monoclonal antibodies like trastuzumab for HER2-positive breast cancer.

Immunotherapies:

Activate or modulate the immune system to target cancer. Immune checkpoint inhibitors (e.g., pembrolizumab) and CAR T-cell therapy (e.g., axicabtagene ciloleucel) are promising advancements in this field.

Hormonal therapies:

Target cancers driven by hormones, such as tamoxifen for estrogen receptor-positive breast cancer and enzalutamide for prostate cancer.

Antibody-drug conjugates (ADCs):

Combine a monoclonal antibody with a cytotoxic agent, allowing for selective delivery of the drug to cancer cells. Examples include brentuximab vedotin and trastuzumab emtansine.

Challenges in Anticancer Drug Discovery

Anticancer drug discovery faces numerous challenges due to the complexity of cancer biology and the need for therapies that are both effective and safe. Below are the key challenges in this field:

Tumor Heterogeneity

Inter-patient heterogeneity:

Cancers can vary greatly between patients, even if they originate in the same organ. This means that a drug that works well for one patient may not be effective for another due to different genetic mutations, epigenetic changes, or microenvironment conditions.

Intra-tumor heterogeneity:

Within a single tumor, there are often multiple subclones with distinct genetic and phenotypic profiles. This diversity within the tumor allows some cancer cells to evade treatment, leading to incomplete tumor eradication and potential relapse.

Drug Resistance

Intrinsic resistance:

Some cancers are inherently resistant to certain drugs due to pre-existing genetic mutations or the activation of compensatory pathways that bypass the drug's effect.

Acquired resistance:

Even if a drug initially works, cancer cells can evolve and develop resistance over time. Mechanisms of resistance include:

Mutation of the drug target:

Cancer cells may mutate the target of a drug, making the drug ineffective (e.g., mutations in the EGFR or BCR-ABL gene).

Activation of alternative pathways:

Cells may activate alternative signaling pathways that allow them to continue growing despite drug treatment.

Efflux pumps:

Cancer cells can upregulate efflux pumps like P-glycoprotein, which actively pump the drug out of the cells, reducing its intracellular concentration and efficacy.

Toxicity and Side Effects

- Many anticancer drugs are cytotoxic and affect both cancerous and healthy cells, especially those that divide rapidly (e.g., cells in the bone marrow, gastrointestinal

tract, and hair follicles). This leads to significant side effects, such as:

- Myelosuppression (suppression of bone marrow activity leading to reduced blood cell production)
- Gastrointestinal toxicity (e.g., nausea, vomiting, diarrhea)
- Cardiotoxicity (e.g., heart damage from drugs like doxorubicin)
- Neurotoxicity (e.g., nerve damage)
- Balancing efficacy with tolerable side effects remains a major challenge, especially in drugs that require high doses to be effective.

Drug Delivery and Tumor Penetration

Solid tumors are often difficult to treat because the drug must penetrate the dense tumor microenvironment, including the extracellular matrix, blood vessels, and immune cells, to reach all cancer cells. Barriers such as:

Poor vascularization:

Some tumors have abnormal or inefficient blood vessels that reduce drug delivery to the tumor interior.

Hypoxia:

Low oxygen levels in parts of the tumor can make cells more resistant to treatment and hinder the activity of certain drugs.

Immune suppression in the tumor microenvironment:

Tumors can create an immunosuppressive environment that inhibits immune responses and limits the efficacy of immunotherapies.

Identification of Valid Targets

- Identifying actionable molecular targets is a critical step, but many targets in cancer are not "druggable." This means:
- Some proteins, such as transcription factors, lack well-defined binding pockets where a small molecule could bind and inhibit their function.
- Redundancies in signaling pathways mean that blocking one target may not be sufficient because cancer cells can activate alternative pathways to sustain their growth.
- Driver vs. passenger mutations: Some mutations in cancer cells do not contribute to the cancer's growth (passenger mutations) and targeting them does not result in therapeutic benefit. Identifying true "driver" mutations that are essential for cancer progression is essential but difficult.

Tumor Microenvironment

- The tumor microenvironment, which consists of non-cancerous cells (such as fibroblasts, immune cells, and endothelial cells), can promote cancer growth and contribute to drug resistance. For example:
- Cancer-associated fibroblasts can produce growth factors that enhance tumor cell survival.
- Immune cells within the tumor, such as regulatory T cells and myeloid-derived suppressor cells (MDSCs), can suppress anti-tumor immune responses, hindering immunotherapies.
- Targeting both cancer cells and the supportive tumor microenvironment is essential but increases the complexity of drug discovery.

Lack of Predictive Preclinical Models

- Traditional preclinical models, including 2D cell cultures and animal models, do not fully replicate the complexity of human cancers. As a result:
- Drugs that show promise in preclinical studies often fail in clinical trials due to differences in how they behave in humans.
- Xenograft models (tumor cells transplanted into immunocompromised mice) do not account for the immune system's role in cancer progression and response to therapy.

- The development of more predictive models, such as 3D organoids and patient-derived xenografts (PDX), is improving, but there is still a need for better models to predict clinical efficacy and toxicity.

Long and Costly Development Process

- Drug development is time-consuming and expensive, with an average timeline of 10–15 years from discovery to approval. Only a small fraction of compounds that enter preclinical testing make it through clinical trials and reach the market.
- High attrition rates are due to failures in efficacy, safety, or pharmacokinetics.
- Costs associated with drug discovery and development are enormous, with estimates exceeding $1 billion for each new drug brought to market.

Regulatory and Ethical Challenges

New drugs must meet stringent regulatory standards set by agencies such as the FDA (U.S.) or EMA (Europe) to ensure safety and efficacy. This requires extensive documentation, clinical trials, and post-market surveillance.

Ethical concerns:

Some cancer patients may have no therapeutic options, and testing experimental drugs on these patients raises ethical issues around informed consent and the risk-benefit ratio.

Emerging Resistance to Immunotherapy

While immunotherapies like immune checkpoint inhibitors have revolutionized cancer treatment, they are not universally effective. Many patients do not respond, and some may develop resistance after an initial response.

Emerging Trends

Personalized Medicine :

Advances in genomics and molecular profiling have enabled personalized medicine approaches, where treatments are tailored to a patient's specific cancer genotype. This is exemplified by the use of biomarkers to guide therapy selection, such as EGFR mutations in lung cancer or BRCA mutations in breast cancer.

Artificial Intelligence (AI):

AI is being applied in drug discovery to predict drug-target interactions, optimize lead compounds, and identify novel drug candidates.

CRISPR and Gene Editing:

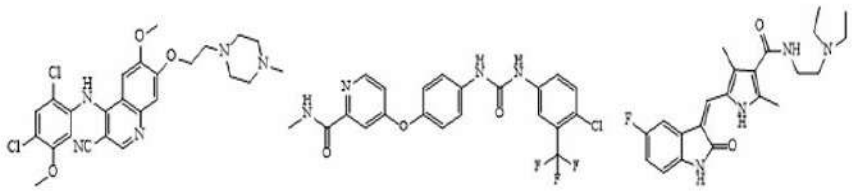
New technologies like CRISPR-Cas9 are being explored for their potential to correct genetic mutations that drive cancer or enhance immune cells' ability to fight tumors.

4. **Recent Advances in Anticancer Drug Targets and Biomarkers**

Targeted therapy is crucial for improving overall survival rates and reducing side effects of cancer treatment. Patients who receive matched targeted therapies show significant improvement in overall survival and progression-free survival compared to those without. Despite numerous drug targets found for cancer treatment, most molecularly targeted agents have been ineffective due to efficacy or toxicity issues. Recent molecular biology work and better understanding of cancer's molecular pathology challenge researchers to focus on the most effective drug targets.

Kinases as targets

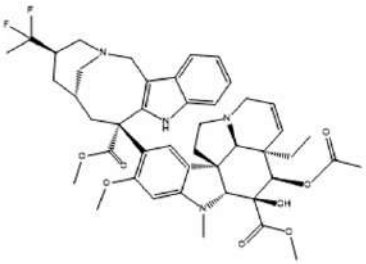
A group of anti-cancer medications known as kinase inhibitors directly interact with the active site of the target enzyme to prevent kinase activity. According to estimates, the human genome contains about 2000 kinases that are either serine/threonine- or tyrosine specific and connected to one another.24 Clinical oncology was first introduced to imatinib, then to bosutinib, sorafenib, and sunitinib. Despite having the same mode of action—competitive ATP inhibition at the tyrosine kinase catalytic binding site—they are distinct from one another in terms of the range of targeted kinases, their pharmacokinetics, and the negative effects that are substance-specific.



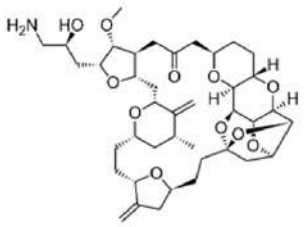
Bosutinib Sorafenib Sunitinib

Tubulin/ microtubule as target

A major component of the eukaryotic cytoskeleton, microtubules are formed by the polymerization of the globular protein tubulin, which has a molecular weight of 52 KD. Through each stage of the cell cycle, microtubules continuously lengthen and shorten. Compared to normal cells, cancer cells rapidly divide and expand. The development of microtubule-targeting agents for the treatment of cancer is being investigated because they are essential for cell division and growth. As a result, the development of anti-cancer medications now includes tubulin as one of their key targets. To find and develop safer and more effective drug candidates, a number of tubulin-targeting agents have been synthesized, and structure-activity relationship studies have been carried out.



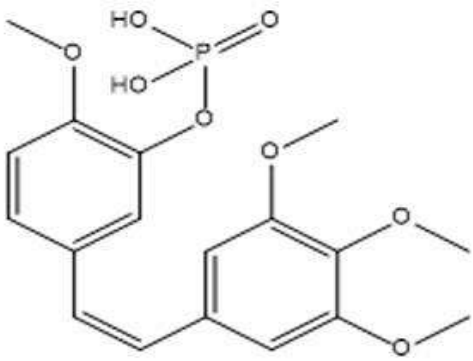
Vinflunine



Eribulin

Vascular targeting agents

Vascular targeting agents (VTAs) are primarily cancer therapies that are created specifically to target the tumor's vasculature and, as a result, prevent the growth and development of tumors. Given the availability of blood borne medications, it becomes a successful strategy in the treatment of cancer. A steady flow of oxygen and nutrients is necessary because tumor cells divide rapidly. Therefore, the growth of blood vessel networks is necessary for the development, progression, and metastasis of tumors. Vascular disrupting agents (VDAs) can stop blood flow to tumors.

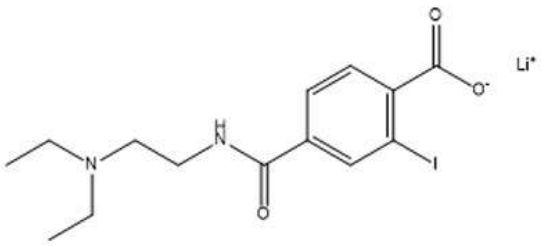


Fosbretabulin

Angiogenesis inhibitors

A brand-new class of medicines called angiogenesis inhibitors is intended to prevent tumor vascularization. VEGF-A is overexpressed in tumor growth, invasion, and metastases. Targeting VEGF-A at the moment are VEGF A

and VEGFR2 inhibitors. Non-small-cell lung cancer (NSCLC) is treated with angiogenesis inhibitors, such as bevacizumab and ramucirumab. These medicines aim to block VEGFs.



Bevacizumab

Monoclonal antibodies

To stop tumor vascularization, a new class of drugs called angiogenesis inhibitors is being developed. Tumor growth, invasion, and metastases all exhibit overexpressed VEGF-A. VEGF-A and VEGFR2 inhibitors currently target VEGF-A. Angiogenesis inhibitors (AIs), like bevacizumab and ramucirumab, are used to treat non-small-cell lung cancer (NSCLC). These drugs try to stop VEGFs.

Recent Advances in Drug Repurposing for the Discovery of New Anticancer Drugs

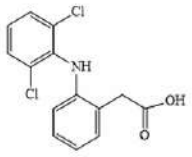
Drug repositioning Sanjay Awonder, also known as drug repurposing can be defined as the process of using aihnüfus other therapeutical application than that for which it was originally developed. a strategy that not only focuses on the other disease apart from the one for After which a drug has already obtained its approval.

Antiplatelet Agents

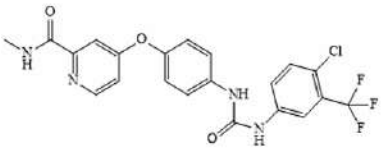
Although aspirin's clinical use as an anticancer medication has been expanded and regular use of the medication is associated with a lower risk of breast cancer, aspirin is primarily used as an antiplatelet medication for cardiovascular diseases. Henry et al. suggests that aspirin and PI3K inhibitors may be used in combination therapy to treat breast cancer.

Anti-inflammatory drugs

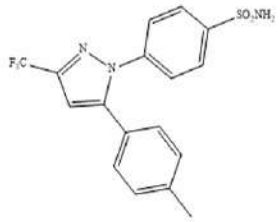
According to recent in vivo data, diclofenac successfully slows the growth of pancreatic tumors in mice. Diclofenac therapy resulted in a rise in apoptosis and a fall in angiogenesis, according to analysis of the tumor tissue removed during surgery. Additionally, melanoma cells were used to test the effectiveness of a diclofenac and sorafenib (a kinase inhibitor) combination, and the results were positive for all cancer cells. Furthermore, in in vivo rat models, the selective COX-2 inhibitor celecoxib inhibited the growth of breast cancer cells and decreased tumor development. It was discovered that the level of COX-2 expression and the invasiveness of the tumor cells were required for growth inhibition. Mesalazine has also been mentioned as having anti-cancer potential in a variety of cancers, including colorectal cancer, gastric cancer, breast cancer, and colon cancer.



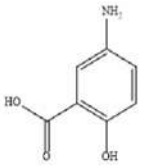
Diclofenac



Sorafenib



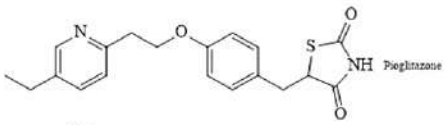
Celecoxib



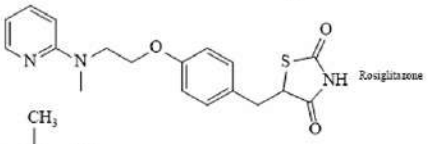
Mesalazine

Antidiabetic agents

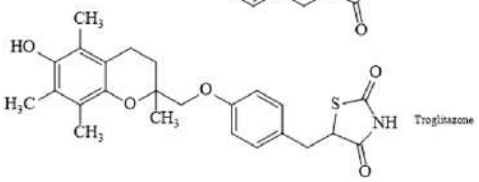
The first line of treatment for type 2 diabetes mellitus is metformin, an oral medication. Numerous cancer types, including pancreatic, endometrial, breast, lung, and prostrate, have shown it to have anti-neoplastic activity. Through numerous preclinical and clinical studies, thiazolidinediones (TZDs) have been identified as a potent lead in the treatment of breast and prostate cancer. Troglitazone, rosiglitazone, and pioglitazone are the three key components of this medication.



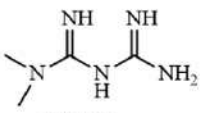
Pioglitazone



Rosiglitazone



Troglitazone

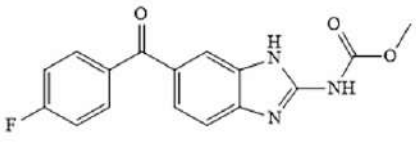


Metformin

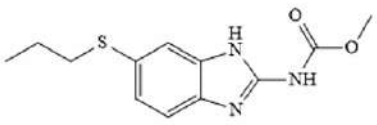
Thiazolidinediones (TZDs)

Anthelmintic agents

Treatment with repurposing pleiotropic benzimidazole anthelminthics like flubendazole and albendazole has recently opened a new window due to their simple accessibility, affordable price as a generic drug, and long history of safe use in the human population. These pleiotropic benzimidazoles are potent microtubule disruptors, anti-angiogenic, checkpoint, anti-metastatic, hypoxia-inducible factor, immune epithelial mesenchymal transition, cancer stemness, and multidrug resistance protein 1 inhibitors, as well as inducers of apoptosis and M1 polarization, according to extensive preclinical research and a small number of clinical trials.



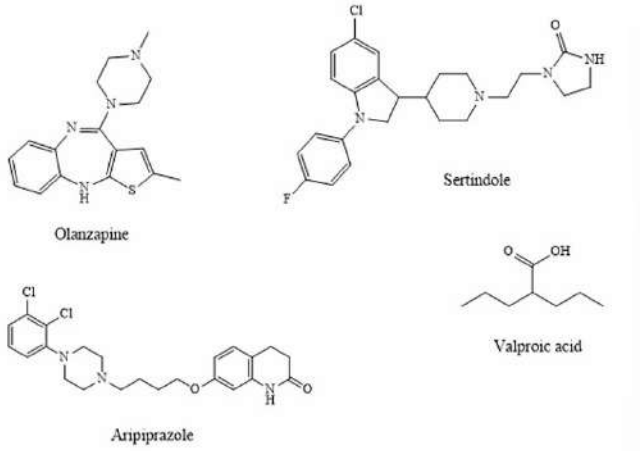
Flubendazole



Albendazole

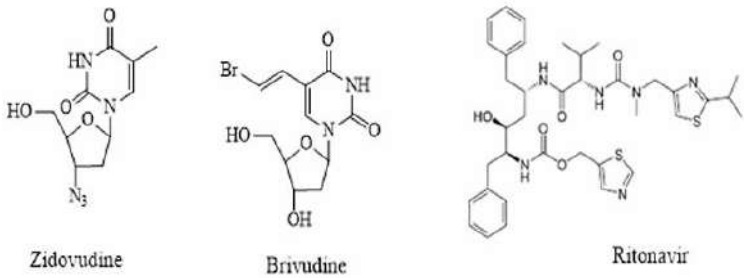
Antipsychotic agents

Several studies have shown that individuals taking antipsychotic medications for psychiatric conditions like schizophrenia have decreased incidences of colon, rectal, and prostate cancer, indicating that antipsychotic medications do have anti-cancer potential. In colon, glioma, and gastric cancer, the drug aripiprazole, which is prescribed to patients with schizophrenia, slows down cell division and tumor growth. Sertindole is a promising candidate drug for the treatment of gastric and breast cancers. Valproic acid, a common neuroleptic drug used to treat epilepsy, bipolar disorder, and migraines, has been found to use epigenetic mechanisms, such as the inhibition of histone deacetylases, which further reduce tumor cell proliferation, cause cell differentiation, and inhibit angiogenesis, ultimately leading to cell death. It has been reported that phenothiazines inhibit DNA polymerase in mitochondria, induce differentiation of tumor stem cells, and decrease tumor cell proliferation. Olanzapine, a medication used to treat bipolar disorder, schizophrenia, and Tourette syndrome, destroys tumor cells by upsetting the homeostasis of cholesterol.44 There is evidence that selective serotonin reuptake inhibitors (SSRI) reduce proliferation, leading to the death of tumor cells.



Antiviral drugs

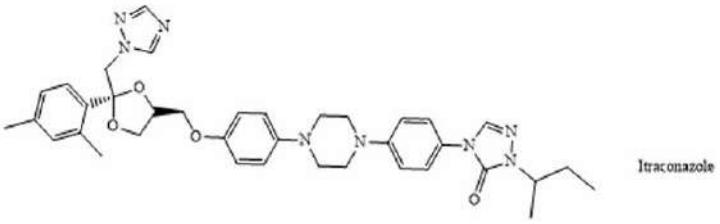
Zidovudine, a reverse transcriptase inhibitor, was the first drug approved to treat HIV infection. It also exhibits anti-cancer properties against a number of cancer types, including pancreatic, leukemia, and Kaposi sarcoma. Similar to this, Brivudine, a medication used to treat herpes simplex virus, demonstrated anti-cancer properties by reducing chemoresistance. In ovarian, pancreatic, and breast cancer cells, ritonavir has been shown to reduce cancer cell growth and division and to speed up apoptosis.



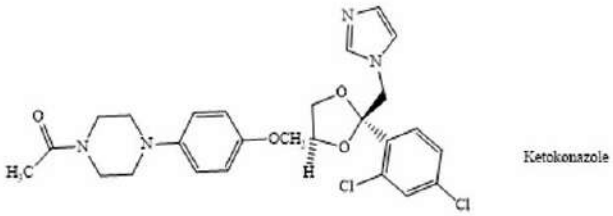
Antifungal agents

The antifungal drug itraconazole is known to inhibit the AKT/mTOR signaling pathway in human umbilical vein endothelial cells (HUVECs), endometrial carcinoma (EC), melanoma cells, and glioblastoma. It regulates the signal transduction pathways of Hedgehog, reverses chemoresistance brought on by P-

glycoprotein, and prevents angiogenesis and lymphangiogenesis in cancer cells. Additionally, ketoconazole demonstrated anti-cancer activity against hepatocellular carcinoma, prostate, melanoma, and breast cancer. It effectively blocks the biogenesis of exosomes in prostate cancer cells while generally being more tolerable and having fewer negative side effects.



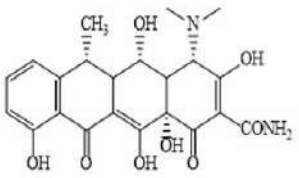
Itraconazole



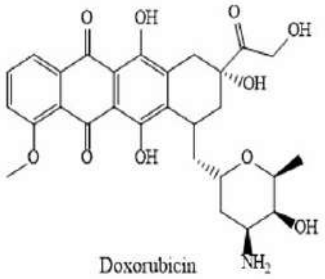
Ketokonazole

Antibacterial agents

Doxorubicin has been found to be effective in treating breast cancer. By intercalating breaks into the DNA, it prevented DNA replication. When combined with a COX-2 inhibitor, doxycycline prevents the growth of colon cancer cells by causing G0/G1 arrest and blocking matrix metalloproteinase. Doxycycline inhibits both the mitochondrial biogenesis process and the stem cell phenotype of cancer cells in the context of breast cancer.



Doxycycline

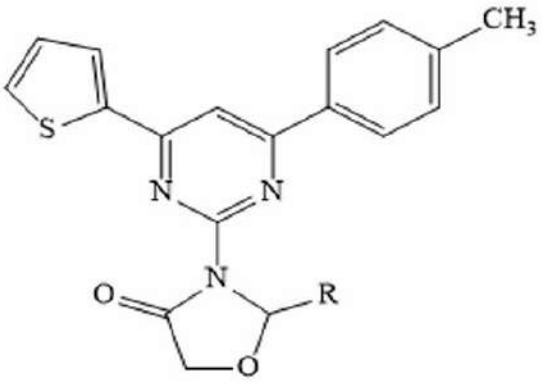


Doxorubicin

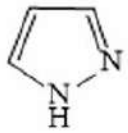
Heterometallic compounds

Though platinum-based drugs are frequently used in medical treatments, their effectiveness is constrained by their toxicity due to interactions between platinum and biomolecules that have sulfur as a donor atom, such as thiols and thioethers. As a result, newly developed mechanisms are creating novel heterometallic complexes with metal centers that have different coordination geometry, kinetic properties, affinity, and reactivity towards biologically relevant nucleophiles in order to overcome the toxicity of platinum-based drugs. Drugs based on heterometallic materials have a promising future for efficacy above those based on platinum, in addition to minimizing toxicity. Platinum, gold, and titanium are more prevalent among With IC50 values ranging from 7 to 19 M against a panel of human cancer cell lines, the synthesis and characterization of a number of novel heterocyclic compounds, including thiazolidin-4-ones, 1,3,4 thiadiazoles, and thiazoles bearing thymol under mild conditions, exhibit significant anticancer activity. Due to its presence in many natural substances, pyrazole, a five-membered ring with two adjacent nitrogen atoms in its structure, has

been postulated as a potent candidate in the pharmacological context with an interesting therapeutic target covering a broad spectrum of biological activities.58 In vitro tests recently revealed progress in the use of bis heterocyclic compounds as efficient anticancer treatments, which goes beyond the concern regarding the anticancer treatment potential of heterocyclic compounds.



Thiazolidin-4-ones



Pyrazole

CONCLUSION:

The global impact of cancer is extremely negative. Beginning with the first nitrogen mustards, researchers and pharmaceutical companies tried their best to find cures. The lack of selectivity, effectiveness, side effects, and metastatic nature of the diseases make effective treatment challenging, despite the availability of a wide range of treatment options as alternatives. Recent advances in the field of molecular biology and a deeper comprehension of the molecular pathology of cancer have pushed researchers to concentrate on the drug targets that can aid in the total eradication of the disease. The discovery of anticancer drugs is outlined in this review's recent highlights. Researchers are now better able to identify specific treatments with lower toxicity and better tolerability thanks to recent advances in drug target and discovery. Numerous drug targets have been found for the treatment of cancer based on a variety of articles written by academics, in order to improve their efficacy and decrease their toxicity. The most effective cancer treatment focuses are kinase, microtubulin, vascular targeting, angiogenesis, and monoclonal antibodies. Researchers look into alternative uses of a drug that has already been approved for one condition for other diseases in addition to its original indication in order to significantly reduce the cost, labor, and research time. Antiplatelet, antidiabetic, anti-inflammatory, antimicrobial, and antipsychotic agents are among the repurposed medications that are mentioned. A popular method for finding new classes of anticancer agents as well as their inventive modes of action is through the discovery of phytochemicals. Quercetin, ginseng, artemisinin, and curcumin all have the potential to fight cancer. On the other hand, natural products are recognized as superior and more potent chemotherapeutic agents. A significant amount of anticancer activity is exhibited by newly developed mechanisms that are designing novel heterometallic complexes with metal centers and heterocyclic and bis-heterocyclic substances like thiazolidin-4-ones, 1,3,4-thiadiazoles, and thiazoles to overcome the toxicity of chemotherapies A large measure of anticancer activity is demonstrated by newly emerged mechanisms that are synthesizing new heterometallic complexes at metal centres and

heterocyclic/bis-heterocyclic compounds such as thiazolidin-4-ones, 1,3,4-thiadiazoles, and thiazoles, to effectively eradicate the toxicity of chemotherapy..

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