A Review on Medicinal Classification of Anti Neoplastic Agents

Keywords: Cancer, abnormal tissue growth, DNA, apoptosis

ABSTRACT

Cancer is a group of diseases characterized by uncontrolled cell division that leads to abnormal tissue growth. The major types of cancer are carcinoma, sarcoma, melanoma, lymphoma, and leukemia. One woman dies of cervical cancer every 8 minutes in India. For every 2 women newly diagnosed with breast cancer, one woman dies of it in India. Mortality due to tobacco use in India is estimated at upwards of 3500 persons every day. Tobacco (smoked and smokeless) use accounted for 3,17,928 deaths (approx.) in men and women in 2018. Antineoplastics or anticancer drugs affect the activity of cell division i.e. are antiproliferative. They damage the DNA and initiate apoptosis, halting the development and expansion of neoplastic cells. They also affect quickly dividing normal cells, therefore are likely to repress the bone marrow, repress growth, impair healing, cause sterility and cause hair loss. The present review therefore is an attempt to focus on classification of Antineoplastic Drugs with Structure.
INTRODUCTION -

Cancer - The term “Cancer” is derived from the Greek word “Karkinos”. Cancer is the name given to a group of related diseases. In all types of cancer, some of the body’s cells begin to split without stopping and spread into nearby tissues. Cancer can start virtually anywhere in the human body, which is made up of trillions of cells.[1][2]

Classification- Cancers are classified by the type of cell that the tumor cells resemble and are therefore presumed to be the origin of the tumor. These types include:

- **Carcinoma**: Cancers originated from epithelial cells. This group comprises many of the most common cancers and include almost all those in the breast, prostate, lung, pancreas and colon.

- **Sarcoma**: Cancers rising from connective tissue (i.e. bone, cartilage, fat, nerve), each of which matures from cells originating in mesenchymal cells outside the bone marrow.

- **Lymphoma and leukemia**: These two classes arise from hematopoietic (blood-forming) cells that leave the core and tend to develop in the lymph nodes and blood, respectively.

- **Germ cell tumor**: Cancers derived from pluripotent cells, most often presenting in the testicle or the ovary (seminoma and dysgerminoma respectively).

- **Blastoma**: Cancers derived from immature "precursor" cells or embryonic tissue.

Epidemiology- According to the National Cancer Registry Programme of the India Council of Medical Research (ICMR), more than 1300 Indians dies every day due to cancer. Between 2012 and 2014, the mortality rate due to cancer increased by approximately 6%. In 2012, there were 478,180 deaths out of 2,934,314 cases reported. In 2013 there were 465,169 deaths out of 3,016,628 cases. In 2014, there were 491,598 people died in out of 2,820,179 cases. According to the Population Cancer Registry of Indian Council of Medical Research, the incidence and mortality of cancer is highest in the north-eastern region of the country. Breast cancer is the most common and stomach cancer is the leading cause of death by cancer for the population as a whole. Breast cancer and lung cancer kill the most women and men respectively.[7]
Antineoplastic drugs are medicines used to treat cancer. Antineoplastic drugs are also called anticancer, chemotherapy, chemo, cytotoxic, or hazardous drugs.[8]

Classification-

1. Cytotoxic antineoplastics.

2. Targeted antineoplastics.

1. Cytotoxic-

a. Nucleoside analogues.

- Azacitidine
- Capecitabine
- Carmofur
- Cladribine
- Clofarabine
- Cytarabine
- Decitabine
- Floxuridine
- Fludarabine
- Fluorouracil
- Gemcitabine
- Mercaptopurine
- Nelarabine
- Pentostatin
- Tegafur
- Tioguanine

b. antifolats-

- Methotrexate
- Pemetrexed
- Raltitrexed

c. Other antimetabolites-

- Hydroxycarbamide
d. **Topoisomerase I inhibitor**-

- irinotecan
- topotecan

e. **Anthracyclines**-

- Daunorubicin
- Doxorubicin
- Epirubicin
- Idarubicin
- Mitoxantrone
- Valrubicin

f. **Podophyllotoxins**-

- Etoposide.
- Teniposide.

 g. **Taxanes**-

- Cabazitaxel.
- Doocetaxel.
- Paclitaxel.

 h. **Vinca alkaloids**-

- Vinblastine
- Vincristine
- Vinflunine.
- Vinorelbine.
- Vinodesine.

 i. **Alkylating agents**-

- Bendamustine.
- Busulfan.
- Carmustine.
- Chlorambucil.
- Cyclophosphamide.
- Decarbazine.
- Fotemustine.
- Ifosfamide.
- Lomustine.
• Melphalan.
• Streptozocin.

j. **Platinum compounds**-
• Carboplatin.
• Cisplatin.
• Nedaplatin.
• Oxaliplatin.

k. **Miscellaneous**-
• Altretamine.
• Bleomycin.
• Bortezomib.
• Dactinomycin.
• Estramustine.
• Ixabepilone.
• Mitomycin.
• Procarbazine

2. **Targeted antineoplastics**-

A. **Monoclonal antibodies**-
• Alemtuzumab.
• Bevacizumab.
• Cetuximab.
• Denosumab.
• Ofatumumab.
• Panitumumab.
• Pembrolizumab.
• Pertuzumab.
• Rituximab.
• Pertuzumab.
• Trastuzumab.
B. Tyrosine kinase inhibitor-

- Afatinib.  
- Afibercept.  
- Axitinib.  
- Bosutinib.  
- Crizotinib.  
- Dasatinib.  
- Erlotinib.  
- Gefitinib.  
- Imatinib.  
- Lapatinib.  
- Nilotinib.  
- Pazopanib.  
- Ponatinib.  
- Regorafenib.  
- Ruxolitinib.  
- Sorafenib.  
- Sunitinib.  
- Vandetanib.

C. mTOR inhibitor-

- Everolimus.  
- Temsirolimus.

D. Retinoids-

- Alitretinoin  
- Bexarotene.  
- Isotretinoin.  
- Tamibarotene.  
- Tretinoin.

E. Immunomodulatory agents[IMiDs]

- Lenalidomide.  
- Pomalidomide.  
- Thalidomide.

F. Histone deacetylase inhibitors-

- Panodinostat.  
- Romidesin.
• Valproate.

• Vorinostat.

G. Other agents-

• Anagrelide.

• BCG vaccine.

• Arsenic trioxide.

• Denileukin diftitox.

• Asparaginase.

• Vemurafenib.

Structures-

Nucleoside analogues-

<table>
<thead>
<tr>
<th>Azacitidine</th>
<th>Capecitabine</th>
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<tr>
<td>Clofarabine</td>
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<td>Decitabine</td>
<td>Floxuridine</td>
<td>Fludarabine</td>
<td>Fluorouracil</td>
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</table>
Gemcitabine

Mercaptopurine

Tegafur

Tioguanine

Antifolates-

Methotrexate

Raltitrexed

Pemetrexed

Topoisomerase I inhibitor-

Irinotecan

Topotecan

**Anthracyclines-**

<table>
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<tr>
<th>Compound</th>
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<tr>
<td>Mitoxantrone</td>
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**Podophyllotoxins-**

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<td>Teniposide</td>
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**Taxanes-**

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<td>Docotaxel</td>
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Vinca alkaloids-

Vinblastine

Vincristine

Vindesine

Vinflunine

Alkylating agents-

Bendamustine

Busulfan

Carmustine

Chlorambucil

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>Molecular Structure</th>
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<td>Fotemustine</td>
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<tr>
<td>Streptozocin</td>
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Miscellaneous-

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Monoclonal antibodies-

Tyrosine Kinase Inhibitor

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<tr>
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<tr>
<td>Ruxolitinib</td>
<td>Sorafenib</td>
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</table>
Sunitinib

Vandetanib

mTOR inhibitor-

Everolimus

Temsirolimus

Retinoids-

Alitretinoin

Bexarotene

Tamibarotene

Tretinoin

Immunomodulatory agents-

Lenalidomide

Pomalidomide

Histone Deacetylase inhibitor-

Panodinostat

Valproate

Romidepsin

Vorinostat
CONCLUSION:

Cancer is becoming a high profile disease in developed and developing countries. In 2007 the WHO published that in 2005, 7.6 million people died from cancer related diseases with the majority of these people living in low-income countries.\textsuperscript{10} Chemically-derived drugs have been developed and other cancer treatments pre-exist. However, current methods such as chemotherapy have their limitations due to their toxic effects on non-targeted tissues furthering human health. Many treatment options for cancer exist. The primary ones include surgery, chemotherapy, radiation therapy, hormonal therapy, targeted therapy and palliative care. Which treatments are used depends on the type, location and grade of the cancer as well as the patient's health and preferences. The treatment intent may or may not be curative.

REFERENCES:

3. WHO Summary report on HPV & cervical cancer statistics in India (18/03/2008)