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Chemotherapy- A Treatment of Cancer

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ABSTRACT

Chemotherapy, also called “chemo,” is treatment with drugs that block or slow down cell growth, most often for cancer. There are many chemotherapy drugs, and often several are given together. The most widely used modality in cancer therapy is chemotherapy. Chemotherapy is the treatment of cancer with drugs that can destroy cancer cell, in contact with local therapies such as surgery and radiation therapy. Anticancer drugs destroy cancer cells by stopping them from growing or multiplying. The term was coined in the early 1900s by Paul Ehrlich as meaning any use of chemicals to treat any disease, such as the use of antibiotics. The first modern chemotherapeutic agent was arsphenamine, an arsenic compound discovered in 1907 and used to treat syphilis. Chemotherapy is used as primary treatment of cancer and it’s used to shrink the tumor so that offer a treatment such as radiation therapy and surgery are possible.

CHEMOTHERAPY

The most widely used modality in cancer therapy is chemotherapy (Chemo). Chemotherapy means treatment of systemic/topical infection with drugs which have selective toxicity for an invading pathogen (living or multiplying) without harming host cells. It takes advantage of the biochemical and physiochemical differences which exist between microorganism (prokaryotes) and human beings (eukaryotes).

Chemotherapy is the treatment of cancer with drugs that can destroy cancer cell, in contact with local therapies such as surgery and radiation therapy. These drugs often are cell "anticancer" drugs. Anticancer drugs destroy cancer cells by stopping them from growing or multiplying. Healthy cell can also be harmed especially those that divide quickly. Harm the healthy cells is what causes side effect. These cells usually repair themselves after chemotherapy.

The drugs used in chemotherapy are able to reach most parts of the body. Therefore, chemotherapy is likely to be recommended for cancer that has already spread to other areas of the body, for tumors that occur at more than one site, or for tumors that cannot be removed surgically. It is also used when a patient has recurrent disease after initial treatment with surgery or radiation therapy.

Every cancer is unique, as is every cancer patient; therefore, the oncologist takes great care to tailor the chemotherapy plan to the particular case. The treatment protocol specifies what type of drug(s) should be given, what dosage should be given, how to administer the drug(s), how often the drug(s) should be given, and how long the treatment should last. During chemotherapy, the oncologist, who may change or modify the treatment plan to achieve better results, closely monitors the progress of the cancer patient and the tumor response.

DEFINATION OF CHEMOTHERAPY

Chemotherapy, also called "chemo," is treatment with drugs that block or slow down cell growth, most often for cancer. There are many chemotherapy drugs, and often several are given together. Depending on the type of cancer, its size, and whether it has spread, chemotherapy may cure the cancer, slow or prevent its spread, or make its symptoms better. For instance, a patient may be given chemotherapy to shrink a tumor before surgery or radiation or to help kill any cancer cells that may be left afterward. Chemotherapy is

sometimes administered with other non-chemotherapy agents such as antibodies that also block or slow down tumor growth.

HISTORY OF CHEMOTHERAPY

The word *chemotherapy* without a modifier usually refers to cancer treatment, but its historical meaning was broader. The term was coined in the early 1900s by Paul Ehrlich as meaning any use of chemicals to treat any disease (*chemo-* + *-therapy*), such as the use of antibiotics (*antibacterial chemotherapy*).[1] Ehrlich was not optimistic that effective chemotherapy drugs would be found for the treatment of cancer.[1] The first modern chemotherapeutic agent was arsphenamine, an arsenic compound discovered in 1907 and used to treat syphilis.[2] This was later followed by sulfonamides (sulfa drugs) and penicillin. In today's usage, the sense "any treatment of disease with drugs" is often expressed with the word *pharmacotherapy*.

The first use of small-molecule drugs to treat cancer was in the early 20th century, although the specific chemicals first used were not originally intended for that purpose. Mustard gas was used as a chemical warfare agent during World War I and was discovered to be a potent suppressor of hematopoiesis (blood production).[3] A similar family of compounds known as nitrogen mustards were studied further during World War II at the Yale School of Medicine. It was reasoned that an agent that damaged the rapidly growing white blood cells might have a similar effect on cancer. Therefore, in December 1942, several people with advanced lymphomas (cancers of the lymphatic system and lymph nodes) were given the drug by vein, rather than by breathing the irritating gas.[4] Their improvement, although temporary, was remarkable [5]. Concurrently, during a military operation in World War II, following a German air raid on the Italian harbor of Bari, several hundred people were accidentally exposed to mustard gas, which had been transported there by the Allied forces to prepare for possible retaliation in the event of German use of chemical warfare. The survivors were later found to have very low white blood cell counts [6]. After WWII was over and the reports declassified, the experiences converged and led researchers to look for other substances that might have similar effects against cancer. The first chemotherapy drug to be developed from this line of research was mustine. Since then, many other drugs have been developed to treat cancer, and drug development has exploded into a multibillion-dollar industry, although the principles and limitations of chemotherapy discovered by the early researchers still apply.[7]

WHY PREFER CHEMOTHERAPY

There are a variety of settings in which chemotherapy may be used in people with cancer:

- **To cure the cancer without other treatments:** Chemotherapy can be used as the primary or sole treatment for cancer.

- **After other treatments, to kill hidden cancer cells:** Chemotherapy can be used after other treatments, such as surgery, to kill any cancer cells that might remain in the body. Doctors call this adjuvant therapy.

- **To prepare you for other treatments:** Chemotherapy can be used to shrink a tumor so that other treatments, such as radiation and surgery, are possible. Doctors call this neoadjuvant therapy.

- **To ease signs and symptoms.** Chemotherapy may help relieve signs and symptoms of cancer by killing some of the cancer cells. Doctors call this palliative chemotherapy.[8]

ROUTE OF ADMINISTRATION OF CHEMOTHERAPUTIC DRUGS

Chemotherapy may be given in several different ways, which are discussed below.

Intravenous (IV) chemotherapy: Many drugs require injection directly into a vein. This is called intravenous or IV chemotherapy. Treatment takes safe w minutes to a few hours. Some IV drugs work better if you get them over a few days or weeks. You take them through a small pump you wear or carry. This is called continuous infusion chemotherapy.

Oral chemotherapy: You can take some drugs by mouth. They can be in a pill, capsule, or liquid. This means that you may be able to pick up your medication at the pharmacy and take it at home. Oral treatments for cancer are now more common. Some of these drugs are given daily, and others are given less often. For example, a drug may be given daily for 4 weeks followed by a 2-week break.

Injected chemotherapy: This is when you receive chemotherapy as a shot. The shot may be given in a muscle or injected under the skin. You may receive these shots in the arm, leg, or abdomen. Abdomen is the medical word for your belly.

Chemotherapy into an artery: An artery is a blood vessel that carries blood from your heart to another part of your body. Sometimes chemotherapy is injected into an artery that goes directly to the cancer. This is called intra-arterial or IA chemotherapy.

Chemotherapy into the peritoneum or abdomen: For some cancers, medication might be placed directly in your abdomen. This type of treatment works for cancers involving the peritoneum. The peritoneum covers the surface of the inside of the abdomen and surrounds the intestines, liver, and stomach. Ovarian cancer is one type of cancer that frequently spreads to the peritoneum.

Topical chemotherapy: You can take some types of chemotherapy in a cream you put on your skin. You get your medication at the pharmacy and take it at home.

TYPES OF CHEMOTHERPUTIC DRUGS

There are more than 100 types of chemotherapy drugs. The main types are:

- **Alkylating agents**: These drugs keep cells from making copies of themselves by damaging their DNA. These drugs work in all phases of the cell cycle. Altretamine, Bendamustine, Busulfan, Carboplatin, Carmustine, Chlorambucil, Cis platin, Cyclophosphamide, Dacarbazine, Ifosfamide, Lomustine, Mechlorethamine, Melphalan, Oxaliplatin, Temozolomide, Thiotepa, Trabectedin

- **Antimetabolites**: Antimetabolites also stop cancer cells from replicating. They do this by acting as a substitute for the normal building blocks of RNA and DNA. Antimetabolites include: Azacytidine, 5-fluorouracil(5-FU),6- mercaptopurine(6MP), Capecitabine (Xeloda, Cladribine, Clofarabine, Cytarabine, Decitabine, Floxuridine, Fludarabine, Gemcitabine, Hydroxyurea, Methotrexate, Nelarabine, Pemetrexed, Pentostatin, Pralatrexate, Thioguanine, combination

- **Anti-tumor antibiotics**: This type of drug changes the DNA inside cancer cells to keep them from growing and multiplying. Anti-tumor antibiotics include: Daunorubicin, Doxorubicin (Adriamycin), Doxorubicin liposomal, Epirubicin, Idarubicin, Valrubicin, Bleomycin, Dactinomycin, Mitomycin-C, Mitoxantrone

- **Topoisomerase inhibitors**: DNA within the body need the enzyme topoisomerase to replicate. Topoisomerase inhibitors stop that process, leading to the death of cancer cells.

- Topoisomerase I inhibitors (also called camptothecins) include: Irinotecan, Irinotecan liposomal, Topotecan.

- Topoisomerase II inhibitors (also called epipodophyllotoxins) include: Etoposide (VP-16), Mitoxantrone (also acts as an anti-tumor antibiotic), Teniposide, Topotecan,

- **Mitotic inhibitors**: Cell division, also known as mitosis, is a crucial part of cancer growth in the body. Mitotic inhibitors stop this process. Examples of mitotic inhibitors include the taxemes and vinca alkaloids. Taxanes include: Cabazitaxel, Docetaxel, Nab-paclitaxel, Paclitaxel. Vinca alkaloids include: Vinblastine, Vincristine, Vincristine liposomal, Vinorelbine

- **DNA repair enzyme inhibitors**: In the event that a cancer cell becomes physically damaged, a DNA repair enzyme, a type of protein, will recognize the damage and attempt to fix it. DNA repair enzyme inhibitors stop this from occurring, which results in the death of cancer cells. DNA repair enzyme inhibitors Lynparza (Olaparib)

- **Plant alkaloids**: Plant alkaloids are agents derived from plants that's top cancer cells from dividing in the body, thus stopping cancer spread and growth. Examples Of alkaloids include morphine, codeine, coniine, quinine, scopolamine, hyoscyamine, atropine, caffeine, sanguinarine, berberine, etc.

- **Antineoplastics**: This type of chemotherapy medication is designed to target and kill cancer cells. Examples of antineoplastic antibiotics included oxorubicin, daunorubicin, bleomycin, mitomycin, and dactinomycin.[9]

Cancer type and common drug combination in chemotherapy:

1. Bone cancer:

Bone cancer is when unusual cells grow out of control in your bone. It destroys normal bone tissue. It may start in your bone or spread there from other parts of your body (called metastasis) [10]

Bone tumors involve the invasion of tumors into bone tissue and are classified as either primary tumors or metastatic tumors. Osteosarcoma is a well-known primary malignant bone tumor that often occurs in children and adolescents. It has been reported that this disease has

become the second leading cause of tumor-related death in young teenagers.[11]

The majority of patients die from lung metastases. Its annual incidence worldwide is

~1–3 cases per million.[12]

To date, the most common clinical treatment methods for bone tumors include chemotherapy, wide surgical resection, and radiotherapy.[13]

2. Stomach Cancer

In stomach cancer (also called gastric cancer), cancer cells usually begin on the inner lining of stomach walls and then penetrate deeper into the stomach walls as the cancer develops. The tumor may grow to involve nearby organs like the liver and pancreas.

Stomach cancer is one of the most common cancers worldwide, but is seen less often in the United States. The number of stomach cancer cases has been steadily declining over the last few decades, possibly because of widespread use of refrigeration that increased access to fresh food without preservatives and bacterial contamination.

Adenocarcinoma of the stomach, a leading cause of cancer death worldwide is the second and fourth most common cancer in males and females respectively [14,15]. Globally, gastric cancer accounts for 989600 new cases and 738000 deaths annually. The case-fatality ratio of gastric cancer is higher than for common malignancies like colon, breast, and prostate cancers [16]

3. Pancreatic cancer

Pancreatic cancer arises when cells in the pancreas, a glandular organ behind the stomach, begin to multiply out of control and form a mass. These cancerous cells have the ability to invade other parts of the body.[17] A number of types of pancreatic cancer are known.

The most common, pancreatic adenocarcinoma, accounts for about 90% of cases, and the term "pancreatic cancer" is sometimes used to refer only to that type. These adenocarcinomas start within the part of the pancreas that makes digestive enzymes. Severe another types of cancer, which collectively represent the majority of the non-adenocarcinomas, can also arise from these cells. About 1– 2% of cases of pancreatic cancer are neuroendocrine tumors, which arise from the hormone-producing cells of the pancreas.[]These are generally less

aggressive than pancreatic adenocarcinoma.

Pancreatic cancer poses a significant diagnostic challenge and the majority of cases present late, with either locally advanced or metastatic disease. The reasons for this are multi-factorial including the non-specific symptoms associated with the disease and the close proximity of major blood vessels which can be readily invaded by the tumor [18]. These factors mean that 80%-85% of tumors are not respectable at the time of presentation [19]. At present, surgical resection is the only potential cure for pancreatic cancer, although rates of recurrence are high with inevitably dismal rates of long-term survival.

4. Colorectal Cancer

Colorectal cancer is a disease in which cells in the colon or rectum grow out of control. Sometimes it is called colon cancer, for short. The colon is the large intestine or large bowel. The rectum is the passageway that connects the colon to the anus.[20]

Colorectal cancer (CRC) is third in terms of recognition (6.1%) and second in terms of mortality (9.2%). It is estimated that by the year 2035, the total number of deaths from rectal and colon cancer will increase by 60% and 71.5%, respectively [21]

The progress of civilization and economic development, apart from improving socioeconomic conditions, also causes a change in dietary patterns, referred to as the westernization of the lifestyle. This means higher consumption of animal fats, processed meats, refined grains or sweets, a low supply of dietary fibers, fruits, vegetables and low physical activity. The occurrence of overweight or obesity is often the result of such a lifestyle.[22]

Overweight and obesity are associated with an increased risk of many civilization diseases. Visceral obesity has been reported to adversely affect the prognosis of CRC in men[23].

5. Lung Cancer

Cancer that forms in tissues of the lung, usually in the cells lining air passages. The two main types are small cell lung cancer and non-small cell lung cancer. These types are diagnosed based on how the cells look under a microscope.[24]

Lung cancer is the second most common cancer in both men and women in the United States

and the number one cause of cancer mortality in both men and women [25]. Twenty five percent of all cancer deaths are due to lung cancer. Unfortunately, most adults with lung cancer present with advanced stages of disease.[26]

Lung cancer is the leading cause of cancer deaths worldwide. People who smoke have the greatest risk of lung cancer, though lung cancer can also occur in people who have never smoked. The risk of lung cancer increases with the length of time and number of cigarettes you've smoked. If you quit smoking, even after smoking for many years, you can significantly reduce your chances of developing lung cancer.

6. Bladder Cancer

Bladder cancer starts when cells that make up the urinary bladder start to grow out of control. As more cancer cells develop, they can form a tumor and, with time, spread to other parts of the body.[27]

There are multiple known risk factors for BC. Important risk factors include smoking, schistosomiasis infection, and occupational exposure to certain chemicals.[28] Smoking is the most important risk factor for BC. The risk of BC in smokers is 2 to 6-fold that of non-smokers; the risk depends on smoking duration and intensity. In developing countries, schistosomiasis infection is an important cause of BC. Schistosoma haematobium ova embed in the bladder wall leading to irritation, chronic inflammation, squamous metaplasia, and dysplasia, with further progression leading to squamous cell carcinoma of the urinary bladder. [29, 30]

7. Germ Cell Tumor

A type of tumor that begins in the cells that give rise to sperm or eggs. Germ cell tumors can occur almost anywhere in the body and can be either benign or malignant.[31]

Intracranial germinomas appear mainly in the pineal and suprasellar regions. Less common locations are the basal ganglia, ventricles, thalamus, medulla oblongata or the cerebral hemispheres [32]

8. Breast Cancer

Breast cancer is a disease in which cells in the breast grow out of control. There are different

kinds of breast cancer. The kind of breast cancer depends on which cells in the breast turn into cancer.

Breast cancer can begin in different parts of the breast. A breast is made up of three main parts: lobules, ducts, and connective tissue.[33]

Breast cancer is the most common type of cancer and the second leading cause of death. This disease is the primary cause of mortality among women aged 45–55 years [34], and is the second leading cause of cancer-induced death. The incidence of breast cancer is almost 1-in-8 women, requiring complete tissue removal, chemotherapy, radiotherapy, and hormone therapy most of the time [35]. Breast cancer is a type of tissue cancer that mainly involves inner layer of milk glands or lobules, and ducts (tiny tubes that carry the milk) [36]

9. Non-Hodgkin lymphoma

Non-Hodgkin's lymphomas (NHL) arise from a single mutant lymphoid cell giving rise to a malignant clone. The genetic changes associated with lymphomatous transformation have been extensively investigated and have contributed greatly to know ledge of tumor genesis in general. Chromosomal abnormalities can be identified in more than 85% of NHL specimens.[37,38]

10.Hodgkin's lymphoma

Hodgkin's lymphoma is a type of cancer that affects the lymphatic system, which is part of the body's germ-fighting immune system. In Hodgkin's lymphoma, white blood cells called lymphocytes grow out of control, causing swollen lymph nodes and growths throughout the body. [39]

ThefirstdescriptionsofwhatcametobeknownasHodgkindiseasedatebackto1832 when the eminent British pathologist Thomas Hodgkin described an autopsy case series of patients with lymphadenopathy and splenic enlargement.[40] It was not till the late 1990s that our understanding of the entity as a malignancy arising from germinal center or post-germinal center B cells led to the term 'Hodgkin lymphoma' (HL) gaining favor [41].

Table No. 1 Cancer types and common drug combination in chemotherapy.

Sr. No	Cancer Types	Drugs combinations
1	Bone Cancer	Doxorubicin, Cisplatin, Methotrexate, Ifosfamide, Etoposide
2	Stomach Cancer	Epirubicin, cisplatin, 5-fluorouracil
		Epirubicin, cisplatin, capecitabine
3	Pancreatic cancer	Gemcitabine, 5-fluorouracil
4	Colorectal cancer	5-fluorouracil, folinic acid, oxaliplatin
5	Lung cancer	Cyclophosphamide, doxorubicin, vincristine, vinorelbine
6	Bladder cancer	Methotrexate, vincristine, doxorubicin, cisplatin
7	Germ cell tumor	Bleomycin, etoposide, cisplatin
8	Breast cancer	Cyclophosphamide, methotrexate, 5-fluorouracil, vinorelbine Doxorubicin, cyclophosphamide
9	Non-Hodgkin lymphoma	Cyclophosphamide, doxorubicin, vincristine, prednisolone
10	Hodgkin lymphoma	Docetaxel, doxorubicin, cyclophosphamide Doxorubicin, bleomycin, vinblastine, dacarbazine Mustine, vincristine, procarbazine, prednisolone

Working of chemotherapeutic drugs

Chemotherapy circulates throughout your body in the bloodstream. So, it can treat cancer cells almost anywhere in the body. This is known as systemic treatment.

Chemotherapy kills cells that are in the process of splitting into 2 new cells.

Body tissues are made of billions of individual cells. Once we are fully grown, most of the body's cells don't divide and multiply much. They only divide if they need to repair damage.

When cells divide, they split into 2 identical new cells. So, where there was1 cell, there are now 2. Then these divide to make 4, then 8 and soon.

In cancer, the cells keep on dividing until there is a mass of cells. This mass of cells becomes a lump, called a tumor.

Because cancer cells divide much more often than most normal cells, chemotherapy is much more likely to kill them.

Some drugs kill dividing cells by damaging the part of the cell's control center that makes it divide. Other drugs interrupt the chemical processes involved in cell division.[42]

Side effects of traditional chemotherapy

Below is a list of common side effects of traditional chemotherapy and ways to overcome:

Fatigue. Fatigue is feeling tired or exhausted almost all the time. It is the most common side effect of chemotherapy.

Pain. Chemotherapy sometimes causes pain. This can include: Headaches, Muscle pain, Stomach pain, Pain from nerve damage, such as burning, numbness, or shooting pains, usually in the fingers and toes

Mouth and throat sores. Chemotherapy can damage the cells inside the mouth and throat. This causes painful sores in these areas, a condition called mucositis.

Mouthsoresusuallyhappen5to14daysafteratreatment.Thesorescangetinfected. Eating a healthy diet and keeping your mouth and teeth clean can lower your risk of mouth sores. Mouth sores usually go away completely when treatment ends.

Diarrhea. Some chemotherapy causes loose or watery bowel movements. Preventing diarrhea or treating it early helps keep you from getting dehydrated (losing too much body fluid).

Nausea and vomiting. Chemotherapy can cause nausea (feeling sick to your stomach) and vomiting (throwing up). Whether you have these side effects, and how much, depends on the specific drugs and dose. The right medications given before and after each dose of chemotherapy can usually prevent nausea and vomiting.

Constipation. Chemotherapy can cause constipation. This means not having a bowel movement often enough or having difficult bowel movements. Other medicines, such as pain medication, can also cause constipation. You can lower your risk of constipation by drinking enough fluids, eating balanced meals, and getting enough exercise.

Blood disorders. Your bone marrow is the spongy tissue inside your bones. It makes new blood cells. Chemotherapy affects this process, so you might have side effects from having too few blood cells. Usually, the number of blood cells return to normal after chemotherapy is complete. But during treatment, low numbers of blood cells can cause problems and must be watched closely.

- Complete blood count (CBC). A **CBC** test shows the levels of red blood cells and white blood cells in your blood.

  - Not enough red blood cells cause a condition called **anemia**. Symptoms include fatigue, dizziness, and shortness of breath.

  - Not enough white blood cells cause a condition called leukopenia. This raises your risk of getting **infections**. When your white blood cells are low, getting an infection can be serious. If this happens, you need antibiotics as soon as possible.

- Platelet count. This test measures the number of platelets in your blood. Platelets are cells that stop bleeding. They do this by plugging damaged blood vessels and helping blood form clots.

  - Not having enough platelets causes a condition called **thrombocytopenia**. You can bleed and bruise more easily than normal.

Nervous system effects. Some drugs cause nerve damage. This can cause the following nerve or muscle symptoms:

Tingling, Burning, Weakness or numbness in the hands, feet, or both Weak, sore, tired, or achy muscles, Loss of balance, Shaking or trembling, Stiff neck or headache, Problems seeing, hearing, or walking normally, Feel clumsy

These symptoms usually get better with a lower chemotherapy dose or after treatment. But damage is sometimes permanent.

Changes in thinking and memory. Some people have trouble thinking clearly and concentrating after chemotherapy. Cancer survivors often call this chemo brain.

Sexual and reproductive issues. Chemotherapy can affect your fertility. For women, this is the ability to get pregnant and carry a pregnancy. For men, fertility is the ability to make a

woman pregnant. Being tired or feeling sick from cancer or treatment can also affect your ability to enjoy sex. Talk with your doctor about these possible side effects before treatment starts.

Appetite loss. You might eat less than usual, not feel hungry at all, or feel full after eating a small amount. If this lasts through treatment, you may lose weight and not get the nutrition you need. You may also lose muscle mass and strength. All these things make it harder to recover from chemotherapy.

Hair loss. Some types of chemotherapy cause hair loss all over your body. It may come out a little at a time or in large clumps. Hair loss usually starts after the first several weeks of chemotherapy. It tends to increase 1 to 2 months into treatment. Your doctor can predict the risk of hair loss based on the drugs and doses you are receiving.

Heart health. Some types of chemotherapy can affect your heart. It can help to check your heart before treatment. This way, doctors can tell if treatment causes problems later. One common test is an **echocardiogram (echo)**. This test uses ultrasound waves to create a moving picture of the heart.

Long-term side effects. Most side effects go away after treatment. But some continue, comeback, or develop later. For example, some types of chemotherapy may cause permanent damage to the heart, lung, liver, kidneys, or reproductive system. And some people have trouble with thinking, concentrating, and memory for months or years aftertreatment.

Nervous system changes can develop after treatment. Children who had chemotherapy may develop side effects that happen months or years aftertreatment. These are called **late effects**. Cancer survivors also have a higher risk of second cancers later in life.[43]

CONCLUSION

Chemotherapy (treatment with cytostatic drugs) can lead to cure for several types of cancer and can alleviate symptoms and extend life in many patients with different forms of cancer. Cytostatic agents not only affect cancer cells but also the growth of normal cells. Hence, treatment carries a major risk for side effects. Different cytostatic drugs have different side effects, and the individual's reaction to chemotherapy varies. A characteristic common to most cytostatic is that they affect the bone marrow and reduce the number of blood cells. This

may increase the risk for severe infections.

The term “curative treatment” is used when the intent of chemotherapy is to cure the patient. The term “palliative treatment” is used when the intent is to ameliorate the patient's pain and other symptoms, but where the potential for cure does not exist. The goalofpalliativetreatmentistoimprovethepatient'squalityoflifeandextendsurvival. In the individual case, the different approaches to treatment may overlap.

Chemotherapy is usually delivered as a series of treatment cycles separated by an interim of one to several weeks so the body's normal cells have the opportunity to recover between cycles. Often 6 to 9 treatment cycles are administered during a 4-to 6-month treatment program, but there are many examples of both shorter and longer treatment programs. In some cases, cytostatic drugs are delivered i high doses to achieve a much greater impact on tumor cells.

REFERENCES

1. DeVita VT, Chu E (November 2008). "A history of cancer chemotherapy". Cancer Research.68(21):8643–53. doi:10.1158/0008-5472.CAN-07- 6611. PMID18974103.
2. Nichols HJ, Walker JE (March 1923). "Experimental Observations on the ProphylaxisandTreatmentofSyphilis".TheJournalofExperimentalMedicine.**37**(4): 525–42.
3. Krumbhaar EB (1919). “Role of the blood and the bone marrow in certain forms of gas poisoning”.JAMA. 72: 39-41.dio:10.1001/jama.1919.26110010018009f.
4. Jump up to:[a] [b] [c]Fenn JE, Udelsman R (March 2011). "First use of intravenous chemotherapy cancer treatment: rectifying the record". Journal of the American CollegeofSurgeons.**212** (3):413–7. doi:10.1016/j.jamcollsurg.2010.10 018. PMID 21247779.
5. Chabner BA, Roberts TG (January 2005). "Timeline: Chemotherapy and the war oncancer".NatureReviews.Cancer.**5** (1):65–72. doi:10.1038/nrc1529. PMID15630416. S2CID205467419.
6. Faguet GB (2005). The War on Cancer. Springer. p. 71. ISBN 978-1-4020-3618- 7.
7. Joensuu H (March 2008). "Systemic chemotherapy for cancer: from weapon to treatment". The Lancet. Oncology. **9** (3): 304.doi:10.1016/S1470-2045(08)70075-5. PMID 18308256
8. https://www.mayoclinic.org/tests-procedures/chemotherapy/about/pac-20385033
9.https://www.cancer.org/treatment/treatments-and-side-effects/treatment-types/chemotherapy/how-chemotherapy-drugs-work.html
10. https://www.webmd.com/cancer/bone-tumors
11. Siclari, V. A. & Qin, L. Targeting the osteosarcoma cancer stem cell. J. Orthop. Surg. Res. 5, 78(2010)
12. Kansara, M., Teng, M. W., Smyth, M. J. & Thomas, D. M. Translational biology of osteosarcoma. Nat. Rev. Cancer 14, 722–735(2014).
13. Bosma, S. E., Wong, K. C., Paul, L., Gerbers, J. G. &Jutte, P. C. A cadaveric comparative study on the surgical accuracy of freehand, computer navigation, and patient-specific instruments in jointpreserving bone tumor resection. Sarcoma 11, 4065846(2018).
14. Danaei G, Vander Hoorn S, Lopez AD, Murray CJ, Ezzati M. Causes of cancer in the world: comparative risk assessment of nine behavioural and environmental risk factors. Lancet. 2005; 366:1784–1793
15 .CatalanoV,LabiancaR,BerettaGD,GattaG,deBraudF,VanCutsemE.Gastric cancer. Crit Rev OncolHematol. 2009; 71:127–164.

16. JemalA,BrayF,CenterMM,FerlayJ,WardE,FormanD.Globalcancerstatistics. CA Cancer J Clin. 2011; 61:69–90.
17."What is Cancer? Defining Cancer". National Cancer Institute, National Institutes of Health. 7 March 2014. Archived from the original on 25 June 2014.Retrieved 5 December2014.
18.CantoMI,HarinckF,HrubanRH,OfferhausGJ,PoleyJW,KamelI,NioY,SchulickRS,BassiC,KluijtI,LevyMJ,ChakA,FockensP,GogginsM,BrunoM;International Cancer of Pancreas Screening (CAPS) Consortium. International Cancer of the Pancreas Screening (CAPS) Consortium summit on the management of patientswith increasedriskforfamilialpancreaticcancer.Gut.2013; 62:339–347.
19.Vincent A, Herman J, Schulick R, Hruban RH, Goggins M. Pancreatic cancer. Lancet. 2011; 378:607–620.
20.https://www.cdc.gov/cancer/colorectal/basic_info/what-is-colorectal-cancer.htm
21.Douaiher J., Ravipati A., Grams B., Chowdhury S., Alatise O., Are C. Colorectal cancer-global burden, trends, and geographical variations. J. Surg. Oncol. 2017; 115:619–630. doi: 10.1002/jso.24578.
22.Murphy N., Moreno V., Hughes D.J., Vodicka L., Vodicka P., Aglago E.K., Gunter M.J., Jenab M. Lifestyle and dietary environmental factors in colorectal cancer susceptibility. Mol. Asp. Med. 2019; 69:2–9. doi: 10.1016/j.mam.2019.06.005.
23.Silva A., Faria G., Araújo A., Monteiro M.P. Impact of adiposity on staging and prognosis of colorectal cancer. Crit. Rev. Oncol. Hematol. 2020; 145:102857. doi: 10.1016/j.critrevonc.2019.102857.
24.https://www.cancer.gov/publications/dictionaries/cancer-terms/def/lung-cancer
25.S.H. Landis, T. Murray, S. Bolden, P. Wingo; Cancer statistics, 1999; CA Cancer J Clin, 49 (1998), pp. 8-31; View Record in Scopus GoogleScholar
26.J.Berhard,P.A.Ganz; Psychosocialissuesinlungcancerpatients(part2); Chest, 99 (1991), pp. 480-485.
27.https://amp.cancer.org/cancer/bladder-cancer/about/what-is-bladder-cancer.html
28.Humphrey PA,MochH,CubillaAL,UlbrightTM,Reuter VE, The 2016 WHO Classification of Tumours of the Urinary System and Male Genital Organs-Part B: Prostate and Bladder Tumours. European urology. 2016 Jul.
29.CumberbatchMG, RotaM,CattoJW,LaVecchia C, The Role of Tobacco Smoke in BladderandKidneyCarcinogenesis:A;ComparisonofExposuresandMeta-analysis of Incidence and Mortality Risks.European urology. 2016 Sep.
30.ZeegersMP, SwaenGM,KantI,GoldbohmRA,van den Brandt PA, Occupational risk factors for male bladder cancer: results from a population-based case cohort study in the Netherlands. Occupational and environmental medicine. 2001 Sep.
31.https://www.cancer.gov/publications/dictionaries/cancer-terms/def/germ-cell- tumor
32.Kakani AB, Karmarkar VS, Deopujari CE, Shah RM, Bharucha NE, GirishM.Germinoma of fourth ventricle: A case report and review of literature. J PediatrNeurosci2006; 1:33–5. [Google Scholar]
33.https://www.cdc.gov/cancer/breast/basic_info/what-is-breastcancer.
34.Jemal A, Siegel R, Ward E, Hao Y, Xu J, Thun MJ. Cancer statistics, 2009.CA Cancer J Clin. 2009; 59:225–249
35.eraviKarimoviM,PourdehqanM,JadidMilaniM,ForoutanSK,AieenF.Studyof the effects of group counseling on quality of sexual life of patients with breast cancer under chemotherapy at Imam Khomeini Hospital. J MazandaranUniv Med Sci. 2006;16(54):43–51.
36.Sariego J. Breast cancer in the young patient. Am Surg. 2010;76(12):1397–1400.
37.Yunis JJ, Frizzera G,OkenMM,McKenna J, Theologides A, Arnesen M (1987) Multiple recurrent genomic defects in follicular lymphoma: a possible model for cancer. N Engl J Med **316**:79–84. PubMedWeb of ScienceGoogle Scholar
38.(1987) Fifth International Workshop on Chromosomes in Leukaemia-Lymphoma. Correlation of chromosome abnormalities with histologic and immunologic characteristics in non-Hodgkin's lymphoma and adult T cell leukaemia- lymphoma. Blood **70**:1554–1564.
39.https://www.mayoclinic.org/diseases-conditions/hodgkins-lymphoma/symptoms- causes/syc-20352646
40.Hodgkin on some Morbid Appearances of the Absorbent Glands and Spleen. Medico-chirurgical transactions. 1832; 17:68–114.
41.Jaffe ES, H N, Stein H, Vardiman JW. World Health Organization Classificationof Tumours: Pathology and Genetics of Tumours of Haematopoietic and Lymphoid Tissues. IARC; Lyon: 2001.

42.https://www.cancerresearchuk.org/about-cancer/cancer-in-general/treatment/chemotherapy/how-chemotherapy.
43.https://www.cancer.net/navigating-cancer-care/how-cancer-treated/chemotherapy/side-effects-chemotherapy.