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Cancer: Role of Nutrition, Pathogenesis, Diagnosis and Management

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Abstract Cancer is characterized by unregulated cell growth. It is one of the most causes of death worldwide. It is attributed to environmental, nutritional and genetic factors. Its clinical presentation varies between local, metastatic and systemic symptoms. Lines of treatment include chemotherapy, radiotherapy and surgical removal.

Keywords: *cancer, nutrition, pathogenesis, diagnosis, management*

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1. Introduction

Cancer is a class of diseases in which a group of cells display uncontrolled growth and invasion that destroys adjacent tissues, and sometimes metastasis to other locations in the body via lymph or blood. These malignant properties of cancers differentiate them from benign tumors, which do not invade or metastasize [1,2].

Researchers divide the causes of cancer into two groups: those with an environmental cause and those with a hereditary genetic cause. Cancer is primarily an environmental disease, though genetics influence the risk of some cancers. Common environmental factors leading to cancer include: tobacco, obesity, infections, radiation, lack of physical activity and environmental pollutants [3]. These factors cause abnormalities in the genetic material of cells. Cell reproduction is a complex process that is regulated by several classes of genes, including oncogenes and tumor suppressor genes. Hereditary or acquired abnormalities in these regulatory genes can lead to the development of cancer [4].

The presence of cancer can be suspected on the basis of symptoms, or findings on radiology. Definitive diagnosis requires the microscopic examination of a biopsy specimen. Treatments of cancer include chemotherapy, radiotherapy and surgery. The prognosis is influenced by the type of cancer and the extent of disease. While cancer can affect people of all ages, the overall risk of developing cancer increases with age [1].

2. Epidemiology of Cancer

In 2008, approximately 12.7 million cancers were diagnosed and 7.6 million people died of cancer worldwide. Cancer accounts for approximately 13% of all deaths each year with the most common being lung cancer, stomach cancer, colorectal cancer, liver cancer and breast cancer. This makes cancer the leading cause of death in the developed world and the second leading cause of death in the developing world [1].

3. Aetiology of Cancer

Cancer is primarily an environmental disease with 90-95% of cases attributed to environmental factors and 5-10% due to genetics. Common environmental factors that contribute to cancer death include: tobacco (25-30%), diet and obesity (30-35%), infections (15-20%), radiation (up to 10%), stress, lack of physical activity, and environmental pollutants [3].

3.1. Chemicals

Cancer pathogenesis is attributed to DNA mutations that impact cell growth and metastasis. Substances that cause DNA mutations are known as mutagens, and mutagens that cause cancers are known as carcinogens. Tobacco smoking is associated with many forms of cancer and causes 90% of lung cancer [5]. Tobacco smoke contains over fifty known carcinogens, including nitrosamines and polycyclic aromatic hydrocarbons [6].

Many mutagens are also carcinogens, but some carcinogens are not mutagens. Alcohol is an example of a chemical carcinogen that is not a mutagen. In Western Europe 10% of cancers in males and 3% of cancers in females are attributed to alcohol [7]. Millions of workers run the risk of developing cancers such as lung cancer and mesothelioma from inhaling asbestos fibers and tobacco smoke, or leukemia from exposure to benzene at their workplaces [4].

3.2. Diet and Exercise

Diet, physical inactivity, and obesity are related to approximately 30–35% of cancer cases [3]. Physical

inactivity is believed to contribute to cancer risk not only through its effect on body weight but also through negative effects on immune system and endocrine system [8]. Diets that are low in vegetables, fruits and whole grains, and high in processed or red meats are linked with a number of cancers. A high salt diet is linked to gastric cancer, aflatoxin B1, a frequent food contaminate, with liver cancer and Betel nut chewing with oral cancer [9]. This may explain differences in cancer incidence in different countries. For example, gastric cancer is more common in Japan with its high salt diet and colon cancer is more common in the United States. Immigrants develop the risk of their new country suggesting a substantial link between diet and cancer [10].

3.3. Infection

Viruses are usual infectious agents that cause cancer but bacteria and parasites may also have an effect [3]. A virus that can cause cancer is called an oncovirus. These include human papilloma virus (cervical carcinoma), Epstein-Barr virus (B-cell lymphoproliferative disease and nasopharyngeal carcinoma), Kaposi's sarcoma herpesvirus (Kaposi's Sarcoma) and hepatitis C virus (hepatocellular carcinoma). Bacterial infections may also increase the risk of cancer, as seen in Helicobacter pylori-induced gastric carcinoma [11]. Parasitic infections strongly associated with cancer include Schistosoma haematobium (squamous cell carcinoma of the bladder) and the liver flukes (cholangiocarcinoma) [12].

3.4. Radiation

Up to 10% of invasive cancers are related to radiation exposure, including both ionizing radiation and non-ionizing radiation. Additionally, the majority of non-invasive cancers are non-melanoma skin cancers caused by non-ionizing radiation from ultraviolet radiation [3]. Radiation can cause cancer in most parts of the body and at any age. Radiation-induced solid tumors usually take long time to become clinically manifest and radiation-induced leukemias require 2–10 years to appear. Some people are more susceptible than average to developing cancer from radiation exposure. Radiation is a more potent source of cancer when it is combined with other cancer-causing agents, such as radon gas exposure plus tobacco smoking [13].

3.5. Heredity

Less than 0.3% of the populations are carriers of a genetic mutation which has a large effect on cancer risk. They cause less than 3–10% of all cancer. Some of these syndromes include Down syndrome patients, who have an extra chromosome 21, are known to develop malignancies such as leukemia and testicular cancer [14].

3.6. Physical Agents

Some substances cause cancer primarily through their physical effects on cells. Prolonged exposure to asbestos is a major cause of lung cancer. Also, naturally occurring and synthetic asbestos-like fibers are believed to have similar effects. Usually, physical carcinogens must get inside the body and require years of exposure to develop cancer [13].

3.7. Physical Trauma and Inflammation

Physical trauma resulting in cancer is relatively rare. It is possible that repeated burns on the same part of the body may produce skin cancer. Frequently drinking hot tea may produce esophageal cancer. Generally, repeated injuries to the same tissues might promote excessive cell proliferation, which could then increase the cancerous mutation [15].

3.8. Hormones

Some hormones participate in the development of cancer by promoting cell proliferation. Hormones are important agents in sex-related cancers such as cancer of the breast, endometrium, prostate, ovary and testis and also of thyroid and bone cancer. Women who take hormone replacement therapy have a higher risk of developing cancers associated with those hormones. Some treatments approaches depend on reducing hormone levels, and thus discouraging hormone-sensitive cancers [16].

4. Pathophysiology of Cancer

Cancers are caused by a series of mutations. Each mutation alters the behavior of the cells. Cancer is due to failure of regulation of tissue growth. In order for a normal cell to transform into a cancer cell, the genes which regulate cell growth and differentiation must be altered [17]. Oncogenes are genes which promote cell growth and reproduction. Tumor suppressor genes are genes which inhibit cell division and survival. Malignant transformation can occur through the formation of novel oncogenes, the inappropriate over-expression of normal oncogenes, or by the under-expression of tumor suppressor genes. Genetic changes can occur at different levels and by different mechanisms [18].

Large scale mutations involve the deletion or gain of a portion of a chromosome. Genomic amplification occurs when a cell gains many copies of a small chromosomal locus, usually containing one or more oncogenes and adjacent genetic material. Translocation occurs when two separate chromosomal regions become abnormally fused. A well-known example of this is the Philadelphia chromosome which occurs in chronic myeloid leukemia and results in abnormal fusion of chromosomal regions [19]. Small-scale mutations include point mutations, deletion and insertion which may occur in the promoter region of a gene and affect its expression, or may occur in the gene's coding sequence and alter the function or stability of its protein product [20].

Replication of the large amount of data contained within DNA may result in some mutations. If significant mutation occurs, the damaged cells can be self destructed through apoptosis. If the error control processes fail, then the mutations will be passed along to daughter cells. Some environmental factors such as carcinogens, repeated physical injury, heat or ionising radiation make errors more likely to arise and propagate [19].

5. Clinical Manifestations of Cancer

Cancer may be manifested by local symptoms restricted to the site of the primary cancer (swelling, hemorrhage,

ulceration and pain), metastatic symptoms due to the spread of cancer to other locations in the body (enlarged lymph nodes, hepatomegaly or splenomegaly, pain or fracture of affected bones and neurological symptoms) or systemic symptoms due to distant effects of the cancer that are not related to direct or metastatic spread (weight loss, poor appetite, cachexia, fatigue, excessive sweating or anemia) [9,21].

6. Diagnosis of Cancer

Most cancers are initially recognized either because signs or symptoms appear or through screening. Neither of these lead to a definitive diagnosis. People with suspected cancer are investigated with blood tests, X-rays, CT scans and endoscopy. The definitive diagnosis must be confirmed by histological examination of the cancerous cells by a pathologist. This information is useful to evaluate the prognosis of the patient and to choose the best treatment [1].

7. Prevention of Cancer

Cancer prevention is defined as the active measures to decrease the incidence of cancer. The majority of cancer risk factors are environmental or lifestyle-related, thus cancer is largely a preventable disease. Greater than 30% of cancer is preventable by avoiding the risk factors including: tobacco, overweight or obesity, low fruit and vegetable intake, physical inactivity, alcohol, sexually transmitted infections and air pollution [13].

7.1. Dietary

Dietary recommendations to reduce the risk of developing cancer, including reducing intake of foods and drinks that promote weight gain, eating mostly foods of plant origin, limiting intake of red meat and avoiding processed meat, limiting consumption of alcoholic beverages, and reducing intake of salt and avoiding mouldy cereals. There are many reports that reduced meat consumption is associated with decreased risk of colon cancer, and that consumption of coffee is associated with a reduced risk of liver cancer [22]. Studies have linked consumption of grilled meat to an increased risk of stomach cancer, colon cancer, breast cancer and pancreatic cancer [23]. Some studies have found that consuming lots of fruits and vegetables has little if any effect on preventing cancer [24]. Another study showed that consumption of a plant-based diet and lifestyle changes resulted in a reduction in cancer markers in a group of men with prostate cancer [25]. Also, women on low fat diet were found to have a markedly lower risk of breast cancer recurrence [26].

7.2. Medications

The concept that medications could be used to prevent cancer is an attractive one, and many high-quality clinical trials support the use of such chemoprevention. Aspirin has been found to reduce the risk of death from cancer [27]. Daily use of tamoxifen or raloxifene has been demonstrated to reduce the risk of developing breast cancer in high-risk women by about 50% [28]. Finasteride has been shown to lower the risk of prostate cancer [29]. The effect of COX-2 inhibitors such as celecoxib upon the risk of colon polyps have been studied in familial adenomatous polyposis [30].

7.3. Vaccination

Vaccines have been developed that prevent some infection by some viruses that are associated with cancer and stimulate an immune response against cancer-specific epitopes. Human papillomavirus vaccine decreases the risk of developing cervical cancer. The hepatitis B vaccine prevents infection with hepatitis B virus and thus decreases the risk of liver cancer [4].

7.4. Screening

Cancer screening involves efforts to detect cancer after it has formed, but before any symptoms appear. This may involve physical examination, blood or urine tests, or medical imaging. Cancer screening is not possible for some types of cancers, and even when tests are available, they are not recommended to everyone. Universal screening or mass screening involves screening everyone. Selective screening identifies people who are known to be at higher risk of developing cancer, such as people with a family history of cancer [31].

7.5. Genetic Testing

Genetic testing for individuals at high-risk of certain cancers is recommended. Carriers of mutations may then undergo enhanced surveillance, chemoprevention, or preventative surgery to reduce their subsequent risk [32].

8. Management of Cancer

Management of cancer depends upon the type of cancer, the location and grade of the tumor, and the stage of the disease, as well as the general state of a person's health. Many lines for management exist including: chemotherapy, radiation therapy, surgery, immunotherapy, monoclonal antibody therapy and other methods [33].

Complete removal of the cancer without damage to the rest of the body is the goal of treatment. Sometimes, this can be accomplished by surgery, but the ability of cancers to invade adjacent tissue or to spread to distant sites by microscopic metastasis often limits its effectiveness. Surgery often required the removal of a wide surgical margin or a free margin. The effectiveness of chemotherapy is often limited by toxicity to other tissues in the body. Radiation can also cause damage to normal tissue [34].

Experimental cancer treatments are studied in clinical trials to compare the proposed treatment to the best existing treatment. They may be entirely new treatments, or they may be treatments that have been used successfully in one type of cancer and are now being tested to see whether they are effective in another type [35].

Alternative cancer treatments are groups of non-related interventions and include mind–body interventions, herbal preparations, massage, acupuncture, reiki, electrical

stimulation devices and a variety of strict dietary regimens among others [33].

Many physicians are supportive of patients using alternative medicine in addition to standard management, especially for symptoms management, though certain types of alternative herbs or diets could actually interfere with treatments [36].

In people who have metastatic disease when first diagnosed, oncologists should consider a palliative care consult immediately. Additionally, an oncologist should consider a palliative care consult in any patient they feel has a prognosis of less than 12 months even if continuing aggressive treatment [37].

9. Conclusion

Cancer is one of the most important diseases that affect people worldwide. Cancer usually is an environmental disease that is precipitated by genetic factors. Its symptoms are variable and diagnosis involves non-invasive and invasive measures. Preventive measures are the key of successful treatment. Lines of treatment include surgical removal, radiotherapy and chemotherapy. Further studies are needed for early detection and proper management of cancer with the least adverse effects.

Competing Interests

The authors have no competing interests.

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