The Impact of Human Microbiome in the Cause, Prevention and Treatment of Several Cancers

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Abstract

This review discusses the major role of Microbiome and its procedure in the prevention and the cause of some important cancers. Nearly 30 trillion bacterial cells are living in or on each human. In addition to digestion, microbes are also supported by immune function, metabolism, and reproduction. While microbes play an important role in maintaining human health and vice versa. There are some major Bacteria play main roles in causing many cancer types. Helicobacter pylori (H. pylori) causes breast and skin cancers. F. nucleatum induces an inflammatory response and activation of cancer-promoting genes. The activation of these genes was found to increase the rate of proliferation in colorectal cells. The human papillomavirus (HPV) is responsible for nearly all cases of anal and cervical cancer. These viruses are also responsible for many cases of mouth and throat cancers. Several studies, however, have found F. nucleatum in colorectal adenomas and advanced-stage colorectal cancer. All types of pathogens cause inflammation and correlate with cell proliferation (damaging mitochondria in the cell) which causes cell apoptosis and results in human diseases mainly cancer that discussed in this review. There are also some microbes are under investigation in the control and treatment of cancer which has been gone through in the article.

Keywords: Cancer Micr; biome; Helicobacter pylori (H. pylori); pathogens; human papillomavirus; Helicobacter hepaticus (H. hepaticus); Fusobacterium nucleatum (F. nucleatum)

Introduction

Cancer

Cancer is a group of diseases that involve abnormal cell division and growth, with the potential to invade or spread to other parts of the body (Metastasis which is called metastasis [1]. Not all tumors are cancerous. Benign tumors do not spread to other parts of the body. Possible symptoms include a lump, abnormal bleeding, prolonged cough, unexplained weight loss, and a change in bowel movements. Although these symptoms may indicate cancer, they may have other causes [2]. Over 100 kinds of cancers affect mammals [3]. Tobacco use is the cause of around 22 percent of cancer deaths. Another 10 percent is due to obesity, poor diets, lack of physical activity, and drinking alcohol [4]. Other factors include certain infections, exposure to ionizing radiation and environmental pollutants, and also certain viruses and parasites [5]. In the developing world, nearly 20% of cancers are due to infections like hepatitis B, hepatitis C and human papillomavirus (HPV). These factors act by changing the genes of a cell. Typically, many genetic changes are required before cancer develops [6,7].

Figure 1: Cancer Cell.
Human Microbiome

Large and diverse populations of bacteria, viruses, and fungi occupy almost every surface of the human body [8]. It is estimated that there are nearly 30 trillion (3 x 10^{13}) bacterial cells living in or on each human. That is about one bacterium for every cell in the human body [9]. These microbes are collectively known as the microbiome [3]. Exposure to microbes first occurs during birth and is later influenced by environmental factors, such as diet and exposure to antibiotics which has become an epidemic of antibiotic resistance and adapted many pathogens to the drugs [8-10]. Due to differences in the environment, diet, and behavior, the specific types of microbes that make up the microbiome can vary greatly between individuals. It is thought that every person’s microbiome is slightly different. Some researchers have done to investigate the use of microbiome to identify individuals, much like fingerprints [11].

Figure 2: Hepatitis B Virus.

Figure 3: Human papillomavirus (HPV).

Material and Methods

In general, acute inflammation is mediated by granulocytes, however; chronic inflammation is mediated by mononuclear cells such as monocytes and lymphocytes. We have investigated many types of research and books to find the Microbiome in/on the human body and their relation to Cancer. Every pathogen including bacteria, cause inflammation in target tissue/cell.

[1] Stomach Cancer

Helicobacter pylori (H. pylori), a spiral-shaped bacterium, provides one of the clearest links between micro and cancer development. H. pylori infections are common; the Centers for Disease Control and Prevention (CDC) estimates two-thirds of the world population carries the bacterium. H. pylori infections are spread by contaminated food and mouth-to-mouth contact. When this pathogen gets inside the host, H. pylori burrows into the mucous layer that lines the stomach. This protected area makes it difficult for the host’s immune system to clear the bacterium. H. Pylori infections do not cause illness in most individuals; however, infection is a major risk factor for ulcers and gastric cancer. Population studies have shown H. pylori-infected individuals are eight times more likely to develop gastric cancer than non-infected individuals. The exact mechanism by which H. pylori infection increases the risk for ulcers and cancer is unknown. There is evidence to suggest that long-term inflammation triggered by H. pylori infection promotes cancer development. The CDC

Figure 4: Gut Bacteria.

Figure 5: Helicobacter pylori (H. pylori).
recommends testing and treatment for H. pylori after removal of early-stage gastric cancer and individuals with a history of ulcers [12].

Breast Cancer

In 2016 researchers identified populations of microbes living in breast tissue [13]. The implications of breast tissue microbiome are just beginning to be explored [14]. Interestingly, breast tissue affected by the benign and malignant (cancerous) disease was shown to have different populations of bacteria [15]. It is unclear if the differences in breast microbiome help to cause the development of tumors or is a result of the disease. In the lab, specific bacteria have been linked to tumor progression [14]. Mice with a predisposition to developing cancer were infected with Helicobacter hepaticus (H. hepaticus). Infected mice had increased mammary gland tumor burden and inflammation compared to uninfected mice. These results suggest that H. hepaticus can contribute to cancer progression by promoting inflammation [15].

Figure 6: Helicobacter hepaticus.

Skin Cancer

The skin microbiome is diverse and differs by anatomical location [14]. Studies done in mice suggest the microbiome can have either protective or harmful roles in cancer development. Mice treated with antibiotics (to kill their microbiome) have an increased risk of melanoma skin cancer and shorter average survival times. These results suggest that the microbiome plays a protective role against the development of this cancer type. On the other side, there is also evidence that the protein flagella of some bacteria that promote chronic inflammation, leading to tissue damage and ultimately skin cancer. In the lab, mice were genetically modified so that they were unable to respond to bacterial flagella. It was found that these mice were protected against an artificially induced cancer, which indicates the inflammatory response to gut bacteria can drive the development of cancer [16].

Figure 7: Bacterial flagella.

Colorectal Cancer

In healthy individuals, the bacterium Fusobacterium nucleatum (F. nucleatum) is commonly found living in the mouth. Several studies, however, have found F. nucleatum in colorectal adenomas and advanced-stage colorectal cancer. It has been found that F. nucleatum causes an inflammatory response and activation of cancer-promoting genes. The activation of these genes was found to increase the rate of proliferation in colorectal cells [17].

Figure 8: Fusobacterium nucleatum (F. nucleatum).

Cervical, Oral and Anal Cancers

Approximately 15% of all human cancers may be attributed to viruses. The human papillomavirus (HPV) is responsible for nearly all cases of anal and cervical cancer. These viruses are also responsible for many cases of mouth and throat cancers [18]. In healthy individuals, papillomaviruses are a common part of the skin and mucosal macrobiotic [19]. Viruses are also associated with liver cancer (Examples are: hepatitis B virus (HBV) or hepatitis C virus (HCV),(hitherto)Uganda S virus which contaminated by some mosquitos) and skin cancer [13-15].

Discussions

The Microbiome and Cancer Treatment

The impact of the human microbiome on cancer treatment is just beginning to be explored. Recent studies have highlighted the importance and potential impact of microbes on disease recovery [14]. Interestingly, the microbiome can support the immune system in the fight against cancer. For example, cyclophosphamide is a drug used to treat leukemia and lymphomas were found to influence the microbes living in the gut. These gut microbes responded by promoting the creation of immune cells, which seems to enhance cyclophosphamide efficacy [20]. As we have seen in the previous sections, microbes have been shown to promote cancer development by inducing inflammation. This inflammatory response can also have a beneficial impact on cancer treatments. Some therapies, such as platinum chemotherapy and CpG-oligonucleotide immunotherapy, are dependent on inflammation. Mice that were treated with antibiotics (which killed the gut microbiome) did not respond as well to platinum chemotherapy or CpG-oligonucleotide immune therapy compared to mice with intact gut microbes. These results suggest that the gut microbiome enhances the effects of...
therapies that are dependent on inflammation [21]. How microbes promote immunity and what this means for humans is still being investigated. It is clear, however, that the microbiome can play an important role in both cancer development and treatment responses. Ultimately, researchers hope to identify and harness microbes that fight cancer and develop ways to eliminate those which promote cancer development [14].

Figure 9: Platinum-Based chemotherapy.

Conclusion

In total, there are ~1,400 known species of human pathogens (including viruses, bacteria, fungi, protozoa, and helminthes). In this article we have mentioned the bacteria which are beneficial microbes that support immune system function, metabolism, and reproduction. And also some pathogens which cause inflammation in the human body and cause cancer or other important diseases. It is estimated that there are nearly 30 trillion (3 x 10−31) microbes that fight cancer and develop ways to eliminate those which promote cancer development [14].

Conflict of Interests

There is no conflict of interest between the authors of this review article.

References


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