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Virus linked cancers, what they are, and how they are treated today

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Abstract

Viruses are now known to be linked to cancer. Seven viruses are responsible for approximately 15% of the worlds cancer diagnoses. Both DNA and RNA viruses can lead to cancerous tumors. Hepatitis B and C, Epstein-Barr virus, Human herpesvirus 8, Human papillomavirus, Human immunodeficiency virus, and Human T lymphotropic virus type 1 are the seven viruses responsible for cancer related to a viral infection. Vaccines are available for four of the seven cancer-linked viruses that are used to help prevent the development of cancers. All of these viruses can be prevent but only some of them can be treated. Liver, stomach, cervical, Kaposi sarcoma, T-cell leukemia/lymphoma are just some of the cancers that can be traced back to these viruses. With an increased amount of research on the vaccines of these viruses and how they contribute to the development of cancers can help prevent specific cancers in the future.

Introduction

In the world there are approximately one million viruses, with about 15% of these viruses being linked to cancer. According to Tristan A. Scott and Kevin V. Morris in their review paper, "Designer nucleases to treat malignant cancers driven by viral oncogenes", about 15% of known caners are caused by viruses. This 15% of virus-linked cancer is caused by only seven viruses. In John B. Liao's "Viruses and human cancer" he mentions the most common viruses linked to cancer. In Viruses and human cancer, John B. Liao the viruses that are considered to be cancer-linked, "Epstein-Barr virus, human papilloma virus, hepatitis B virus, and human herpes virus8 are the four DNA viruses that are capable of causing the development of human cancers. Human T lymphotrophic virus type 1 and hepatitis C viruses are the two RNA viruses that contribute to human cancers." These viruses do not always lead to cancer; it can take years to progress to cancer. "The path from viral infection to tumorigenesis is slow and inefficient; only a minority of infected individuals progress to cancer, usually years or even decades after primary infection." Viruses are also not the only thing needed for them to lead to cancers, according to John B. Liao other factors also have to be present to possibly lead to cancer. In Viruses and human cancer the author, John B. Liao, mentions what other factors need to be present to aid in the formation of cancer where he says, "Virus infection also is generally not sufficient for cancer, and additional events and host factors, such as immunosuppression, somatic mutations, genetic predisposition, and exposure to carcinogens

must also play a role." Virus-linked cancers may be a small percentage of 15%, but this percentage is made up of only seven viruses. These viruses take over the bodies healthy cells and insert their own DNA into host cell, this is what is believed to make these viruses linked to certain cancers. It is believed to be from the virus injected its own DNA causing the healthy cell to change and increase its chances of mutating, which can result in developing cancer.

Two of the viruses mentioned, are Hepatitis B and C, these viruses are what are known as RNA viruses. Hepatitis infects the liver and it is estimated to be about 3% of the world's population are actually carriers for the Hepatitis C virus. This virus is transmittable through blood. Hepatitis C can cause hepatocellular carcinoma. While Hepatitis B is a DNA virus it is very similar to Hepatitis C. Hepatitis B is also transmittable through blood, semen, and body fluids and can also be contagious for up to three months. A chronic infection caused by Hepatitis B can also lead to hepatocellular carcinoma. Hepatocellular carcinoma is a tumor that is a result from liver disease. There are multiple resolutions to treat hepatocellular carcinoma including, "The traditional foundation of treatment is surgical, whether tumor resection or transplantation. However, nonsurgical options such as percutaneous ethanol injection, transarterial embolization, radiofrequency ablation, chemotherapy, and radiotherapy are also utilized.", according to John B. Liao in Viruses and human cancer. According to John B. Liao vaccines utilized in the treatment of Hepatitis B and Hepatitis C are the first cancer prevention vaccine available. In direct quote from his paper Viruses and human cancer, "The introduction of vaccines against Hepatitis B virus in the early 1980s marked a major milestone with what might be considered the first cancer prevention vaccine." There is a vaccine available for prevention against HBV and is recommended for children and adults. As for HCV there is not a vaccine available but is easily treated. HBV is directly related to liver cancer and is the leading cause. HCV is directly linked to liver cancer and Hodgkin's lymphoma as well.

The next cancer-linked virus is the Epstein Barr virus(EBV). This particular virus is transmitted through person to person by their saliva, but there are rare cases where it is transmitted through semen, blood, and even with organ transplants. Epstein Barr virus is a type of herpes virus that is found to be the most common herpes virus in humans today. There is currently no core available for this particular virus. After the first infection/ contraction of EBV the virus will become dormant in the body, but can become reactivated later in life. EBV typically infects people at a younger age, such as children, this is because children tend to share toys that may have previously came into contact with EBV. Patients with Epstein Barr virus are at an increased risk for developing Hodgkin's lymphoma, non-Hodgkin's lymphoma, Burkett lymphoma, and as well as stomach cancer. This particular virus does not have a vaccine available. The best way to decrease your chances of increasing your chances of contracting EBV and as well as the cancers that are linked to EBV is by prevention. Since, EBV is transmitted by saliva the best way to prevent yourself from contracting this is by not sharing food, drinks, eating utensils, and by not kissing anyone who has a known EBV infection. There is also no-known treatment plans specifically for EBV. The treatment suggested for an EBV infection is consuming pain relievers and fever reducers, increase your body's fluids intake to stay hydrated, and resting.

Another cancer-linked virus is the Human papillomavirus more commonly known as HPV. HPV is a sexually transmitted virus that can cause a variety of health complications not just cancer. In 2018 there were approximately 43 million people infected with HPV. The majority

of these patients were mostly in their 20's. HPV can be spread through vaginal intercourse and as well as anal sex. HPV in particular is harder to diagnose at an early stage due to its ability to show symptoms years after your initial contact with HPV. This virus in particular has more than twelve stains that is connected to cancer developments in both men and women. These cancers include cervical, anal, throat, vaginal, penile, and vulvar cancers. There is a vaccine available for prevention of HPV. This vaccine is suggested for both females and males at the age of 11. This vaccine is only available for patients form ages 9-26. There are other ways to help prevent an infection with HPV such as using condoms, letting your sexual partner know if you are HPV positive so they can also take precautions, and only being sexually active with one person. This vaccine is recommended to be given before the age of 27 and under the age of 45 years old. Getting the vaccine in the age range from 27-45 does not cause harm but it does have a lessened benefit of the vaccine. HPV is harder to test for because there is not a test for HPV infections in the throat or mouth area of the body, which lowers the chances of catching the infection early. Another reason HPV may be difficult to diagnose is due to the fact that most women get their first screening for cervical cancer at the age of 30, these test are also not recommended for children and teens, women under 30, and men. When people do become concerned that they may have developed this infection it is usually in the later stages and may only find out when they have developed very serious conditions such as the development of cancer. To put it in perspective approximately 12,000 women are diagnosed with cervical cancer with approximately 4,000 of them dying. HPV is found responsible for cancers in approximately 19,000 women and 12,000 men. There is a vaccine available today that can help prevent these chances of cancers being caused from HPV. Being screened for HPV regularly can also help decrease your chances of developing cancers from HPV.

Another important virus-linked cancer is the Human T-lymphotrophic virus (HTLV-1). This virus is a type of T-cell leukemia that is linked to T-cell leukemia/lymphoma in adults. This virus is transmitted through several routes including blood, sexual contact, sharing needles, and as well as breast feeding. Diagnoses for HTLV-1 is usually done by blood sample test. HTLV-1 is difficult to diagnose because the majority of people never show symptoms and usually get diagnosed on accident when they give blood for donation. There is not a vaccine available for HTLV-1 currently. Since there is not a vaccine for HTLV-1 there is only preventing it in ways such as practicing protected sex, not sharing needles, always screening people that give blood for donations, testing pregnant women before they breastfeed for the first time, and by not breastfeeding if you are infected. With the cancers that are linked to this virus being very aggressive developing any of the cancers linked to HTLV-1 the life expectancy is approximately 6 months to 2 years after being diagnosed.

Another cancer-linked virus is the Human herpes virus(HHV-8). This virus is linked to people that already have a weakened immune system. HHV-8 is linked to Kaposi sarcoma in people with a weak immune system. The true transmission process of HHV-8 is unknown but is speculated to be contacted from saliva during sexual activities. There is not a lot of way to prevent the infection of HHV-8 other than practicing protective sex and getting tested to prevent exposing anyone else. There is no known vaccine available for Human herpes virus.

The last cancer-linked virus is the Human immunodeficiency virus(HIV). This virus is linked to Kaposi sarcoma, cervical cancer, anus, liver, throat, lung, mouth, non-Hodgkin's lymphoma, and Hodgkin's lymphoma. This virus is spread through contaminated semen,

blood, fluids from the vagina, and breast milk. Although this virus is thought to not cause cancer directly but it is thought to contribute to the development of cancer. HIV is a virus that decreases the body's immune system, which in return allows for cancerous cells to develop and thrive resulting in cancer. HIV has three stages acute, chronic, and AIDS. For diagnosis an antigen/antibody or nucleic acid test will be performed. These test are performed with a blood sample. Prevention is key in decreasing your chances of contracting HIV. Efforts such as getting tested often, using protection during sexual intercourse, not using used needles, and take pre-exposure prophylaxis(PrEP) if you have been exposed in the last couple of days. There is not a vaccine available for HIV.

Recent Progress

The most recent discovered virus that is related to cancer is the Merkel cell polyomavirus (MCPyV), mentioned by Tristan A. Scott and Kevin V. Morris. Tristan A. Scott and Kevin V. Morris mention Merkel cell polyomavirus in "Designer nucleases to treat malignant cancers driven by viral oncogenes", saying, "Merkel cell polyomavirus (MCPyV) is the most recently discovered oncogenic virus [93] and is ubiquitously present in the human population as it is acquired in the first years of life, and generally does not cause any symptoms. Polyomaviruses have long been known to transform cultured cells (SV40) [94], but it was many years before MCPyV, the first human oncogenic polyomavirus agent, was found in 80% of Merkel cell carcinomas (MCC), a rare and aggressive skin cancer [93]. MCC occurs in immunocompromised individuals, but mostly in the elderly with a median diagnosis age of ~ 70 years old [95], but with a 95% increase in MCC diagnoses since 2000 [96] and a 5-year mortality rate of > 40%, makes it an aggressive skin cancer in need of therapeutic solutions."

In the last decade or so there has been some developments in the HIV vaccine. In 2009 there was a trial study for the vaccine for HIV done in Thailand. This trial took 6 years to complete. The vaccine trial was set up in two parts. The first part of the vaccine trail took a canary-pox virus and added genes from HIV antigenic proteins. This was meant to increase the T-cell production and response. The second part of the vaccine was meant to increase the production the body's B-cells. In order to do this the second part of the vaccine contained genetically engineered HIV antigenic protein. The vaccine did not show very promising results when they were used alone. Statistics show that the patients that received the combinations of both parts of the vaccine as opposed to only the second part there was a 31% decrease in HIV infections. Unfortunately, the 31% is not significant enough to administer the vaccine to the public. More studies are continuing for the advancement for a HIV vaccine but nothing has been significant enough for public use of the vaccine.

As for any other of the cancer-linked viruses there is little to no new advancements in progress for other vaccines or treatments.

Discussion

There is very little research done of cancer-linked viruses compared to other cancer research topics. These virus-linked cancers included but are not limited to Hepatitis C (HCV), Hepatitis B (HBV), Epstein-Barr virus (EBV), Human papillomavirus (HPV), Human immunodeficiency virus (HIV), Human T-lymphotrophic virus (HTLV-1), and Human herpes virus 8 (HHV-8). Since there is not a lot of research done on how these viruses actually contribute to cancer development it makes this topic hard to inform the public on how they can help themselves in the prevention of cancer-linked viruses. With the increase of more research being done on how viruses cause normal healthy cells to become cancerous it will allow for more prevention and treatment available for these cancers. If researches can figure out exactly

why these specific viruses are cancer-linked it may allow for breakthrough in some treatments for these cancers. With each new vaccine advancement with these particular viruses it is another step closer to decreasing cancers that in other words would not develop unless it was for these viruses. It is important to continue to make advancements in vaccines available for these viruses to help prevent, fight, and treat cancers in the future.

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