International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2022): 7.942

Role of Genetics in Cancer Studies

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Abstract: ***Examiners have recognised that genetic association association of cancer studies are broad and complex, because of various stage processes of the cancer and the daunting issue of analysing genetic variants in family research and population. Researchers may now examine genetic variation and cancer. These studies have alot potential for uncovering many genetic risk factors which contribute to the complicated disease known as cancer, study design and interpretation methodologies must be carefully evaluated. If genetic variation is to realise the promise of personalised treatment, it must be replicated in sufficiently big, well-powered research. In this sense, the investigation of gene& gene and gene & environment interactions is the only way to ensure the plausibility of verified genetic variants.***

Keywords: Genetics, cancer studies, cancer treatment, types of cancer, genetic mutation, hereditary cancer, genes linked to cancer, diagnosis of cancer syndrome, current treatment, gene therapy

1. Introduction

Individual genes or groupings of genes are studied in genetics research to see how these affect the health and the disease. To learn more about promoting health and preventing sickness, it's important to understand the genetic variables and genetic abnormalities. Few genetic variations are linked to a higher risk of producing a child with birth defect or developmental disability, as well as the development of diseases which includes cancer and heart disease. Genetics can also assist us in comprehending how medical disorders develop. People inherit their chromosomes from their parents, which contain their genes. Humans have 46 chromosomes, which are divided into 23 pairs. Children inherit one set of chromosomes from their mother and one pair from their father at random. The sex chromosomes are those which make up the 23rd pair. They determine whether a child is born male or female. Males have one X and one Y chromosome, while females have two X chromosomes. Her mother gives each daughter an X, and her father gives each daughter an X. From his mother, each boy receives an X, and from his father, a Y.

2. Review of Literature

Knowledge gained from annotating the draught order of human genome has advanced the possibility of analysing common germ-line genetic variation and cancer risk. Now, researchers may use genetic variation in diverse groups to look for genetic markers which are linked to cancer risk, therapy response, and outcome.

This new approach, which involves analysing common genetic variation to analyse complicated disorders like cancer, is the first step toward surveying the genome in its entirety. Few other types of variation, like microsatellite markers, insertions and deletions (from a single base to large regions of thousands of bases), and copy number variation, known to exist between individual human's genome but the first large-scale maps for single nucleotide polymorphisms are created (SNPs). When identifying SNPs to analyse in a cancer risk study, it's vital to have a good grasp of population-specific genetic variation in healthy people. It's long been known that incidence of various cancers varies substantially among different communities around the world.

Types of genes linked to cancer

1) Tumor Suppressor Genes-

These are known protective genes, they limit the growth of the cell by-

- Controlling whenever a cell dies,
- Repair of mismatched DNA,
- Monitoring how cells divide into new cells.
  At the point when a tumor suppressor genes mutates, cell grows unconditionally, and they may form a tumor. For example, BRCA1, BRCA2, TR53 or p53.
  Germline mutations in BRCA1 or BRCA2 genes increase a woman's risk of developing hereditary breast or ovarian cancers and a man's risk of development of hereditary prostate cancer. They increases the risk of pancreatic cancer and melanoma in women and men. p53 or TP53 are the most common mutated gene in people with cancer. More than 50% of cancers involve a missing or damaged p53 gene.

2) Oncogenes-

These cells convert a cell into a cancer cell and mutations in these genes are not inherited.

The 2 most common known oncogenes are-

- HER2, which is a specialised protein that controls growth and spread of the cancer and are found in some cancer cells, like ovarian and breast cancer cells.
- The RAS genes, which makes proteins involved in the cell communication ways, cell growth, and it's death.

3) DNA repair genes-

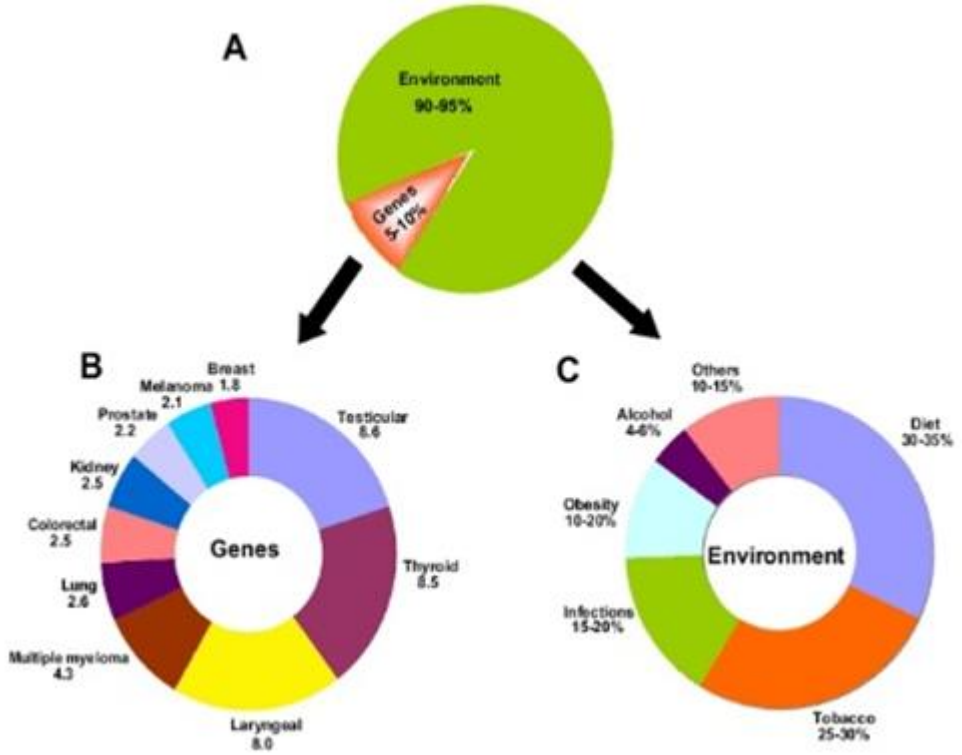
These fix botches made when DNA is replicated. A considerable lot of them work as tumor suppressor genes for example, BRCA1, BRCA2, and p53 are all DNA fix suppressor genes. Like if a person has an error in the DNA repair gene, mistakes remain uncorrected. Then, the mistakes become mutations.

Role of Genetics in Cancer Development

The function of genetics in developing cancer is constantly being discovered. Every cancer type is an occasional

complication of some hereditary condition, usually the rare one, and every cancer type travels in families (which may reflect host or environment factors, or both), and each cancer type is an occasional complication of some hereditary condition (which may reflect host or environment factors, or both). Most cancers have genetic determinants, and while certain common cancers may be linked to a single major mutant gene, rare mutant genes that greatly enhance the risk have been revealed for breast, colon, prostate, ovary, and lung cancers. As a result, critics believe that comprehensive gene research is unnecessary because, number of people which are diagnosed with cancer due to a genetic susceptibility is very modest compared to the total number of cancer patients.

Research has shown that genetic susceptibility to cancer considerably increases the risk of having cancer (in some cases, a mutation on a specific gene can increase breast cancer risk by a starling 80 percent). Knowledge of a person's genetic susceptibility to cancer, as well as appropriate lifestyle modifications, can help them to reduce their risk of developing a disease, and in some circumstances, completely avoid it.



How faulty genes lead to cancer

When cells split, our DNA catch up on mistakes. Mutations are the term for these errors (or flaws). Mutations can occur at any time during our lifetimes as a result of normal cell processes. Or they can happen because of other factors such as: tobacco smoke, high energy (ionising) radiation, such as x-rays, ultraviolet radiation from the sun, some substances in food, chemicals in our environment, people can sometimes inherit defective genes from their parents. They may be at a higher risk of cancer as a result of this.

It's common for cells to fix errors in their genes. When the damage is severe enough, the cell may self-destruct. Alternatively, the immune system. They may be identified as abnormal and killed if you open a glossary item. This aids in cancer prevention.

Genetic mutations and cancer

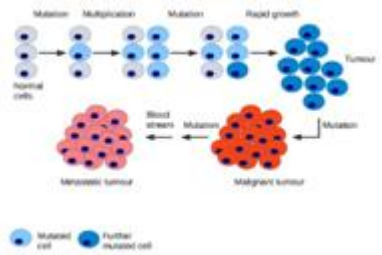
Mutations are common. A mutation might be advantageous, detrimental, or neutral and this is dependent on where the alteration occurs in the gene. Most mutations are usually corrected by the body. It is unlikely that a single mutation will result in cancer. Cancer is usually caused by a series of mutations over the course of a lifetime. As a result, in elderly cancer is more common to occur. They've had greater possibilities to accumulate mutations.

Cancer is a condition in which cells proliferate uncontrollably. This occurs as a result of manipulations in some genes within the cells. Genes are fragments of DNA that regulate how cells generate the proteins that the body requires, as well as how cells maintain their equilibrium. Hair colour, eye colour, and height are all influenced by the genes. They can also increase your risk for contracting diseases like cancer.

Almost all of the genes you were born with are present in nearly every cell in your body. Different cells (or types of cells) may employ different genes, despite the fact that they all have same genes. Muscle cells, for example, utilise different genes than skin cells. Genes that aren't required by the cell are shut off and aren't utilised. The genes that the cell uses are turned on or activated.

Mutation is change in a gene that is aberrant. A gene's function can be affected by mutations. A mutation, for example, could render a gene inactive. It could also keep a

gene active all the time (even when it isn't needed). In either case, this can cause issues within the cell.



There are 2 types of genetic mutations-

1) Acquired (somatic) mutations-

These are the most persistent cancer-causing agents. They are caused by damage to genes in a specific cell during a person's lifetime. This could be a breast cell or a colon cell, for example, which then divides numerous times and forms a tumour. A tumour is a mass that is abnormal. Sporadic cancer is cancer that develops as a result of acquired mutations. Acquired mutations are not seen in all of the body's cells. Acquired mutations are not found in every cell in a body and they aren't passed from parent to child. Factors that cause these mutations include:- Tobacco, Ultraviolet (UV) radiation, Viruses, Age.

2) Inherited (germline) mutations

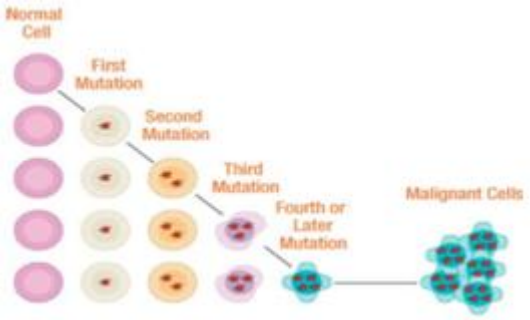
This is a really rare occurrence. In a sperm cell or in an egg cell, a germline mutation occurs. At the time of conception, it is passed straight from a parent to a child. The mutation from the original sperm or egg cell gets copied into every cell in the body as embryo develops into a kid. The mutation can be passed down from generation to generation since it affects reproductive cells. Inherited cancer is cancer caused by germline mutations. It accounts for around 5% to 20% of all cancers.

Identifying Genetic Changes

DNA sequencing tests are lab tests that can "read" DNA. Scientists can uncover genetic disabilities in cancer cells that may charge the progression of an individual's cancer by comparing the sequence of DNA in cancer cells to that of normal cells such as blood or saliva. This information could aid doctors in determining the medicines are most effective against a specific tumour.

This information could aid doctors in determination which medicines are most effective against a specific tumour. Inherited mutations can also be discovered using tumour DNA sequencing. Indeed, genetic testing of tumours has revealed that a patient's cancer may linked to a hereditary cancer disease that the family was unaware of in some situations.

Clinical DNA sequencing, like testing for particular mutations in hereditary cancer syndromes, has ramifications that patients must consider. For example, people may learn by chance that they or their family members have inherited mutations that can cause various diseases.



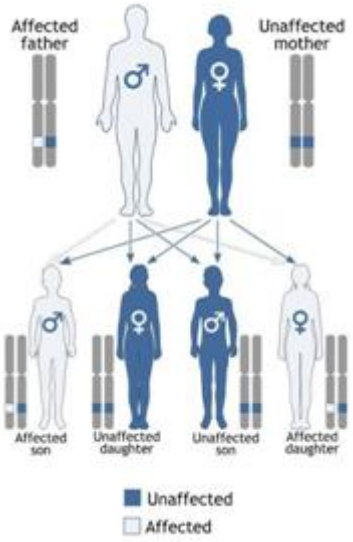
Complexities

The requirement to integrate large population-based research with deep genomic analyses makes studying genetic diversity and its contribution to cancer risk a demanding task. Although others have detailed the intricacy of cancer as a disease, the connection between genes and environment has yet to be thoroughly investigated.

There are variances in the age of onset, tumour growth rate, presence of metastases, pathological appearance, gene expression patterns, somatic genetic mutations, responsiveness to therapy, and familial risk in each form of cancer. As a result, finding common characteristics linked to genetic markers necessitates careful consideration of well-designed research that address specific hypotheses.

Inherited Genes and Cancer Types

People which have inherited gene mutations that make them more susceptible to certain cancers. Some genetic flaws can put you at risk for a variety of cancers. If a close relative has been diagnosed with one or more than one cancers listed below, you may find the information useful.



Types of Cancers

1) Bowel Cancer

One of the most frequent type of cancer is bowel cancer. Some hereditary genes have been linked to an increased risk of bowel cancer and the illnesses listed here.

2) Breast Cancer

It's a prevalent malignancy that affects one in every seven women in the United Kingdom. An inherited defective gene is thought to be the cause of 5 to 10 percent of breast cancers, according to researchers. BRCA1, BRCA2, TP53, PALB2, and PTEN are the genes that greatly enhance the risk of breast cancer & can get tested for it. When someone with breast cancer undergoes a BRCA gene test, the test can occasionally reveal mutations in another gene, such as CHEK2, although nothing is known about the majority of the other genes.

3) Kidney Cancer-

We know that, having family history of kidney cancer increases a person's risk. This could be due to a common way of life or, less frequently, inherited defective genes. Developers are looking for genes which are linked to an increased risk of kidney cancer. There a lot of genetic conditions that enhance the likelihood of developing it, as we know. These disorders are extremely rare, with an estimated incidence of 2 - 4 kidney malignancies per 100 people. The conditions listed below are among them.

4) Ovarian Cancer

About 2/100 women (2%) may acquire ovarian cancer over their lives. BRCA1, BRCA2, and those genes that cause Lynch syndrome are all known to enhance the risk of getting ovarian cancer and can be tested for.

5) Prostate Cancer

Prostate cancer has overtaken lung cancer as one of the most persistent cancer among men. It affects one in every eight men in the United Kingdom at some point during their lives. Over the age of 70, it's the most prevalent. A number of genes have been discovered. that enhance the risk of prostate cancer, according to researchers. For the time being, only a test for the BRCA2 gene is available. Breast and ovarian cancers are most common cancers connected to this gene.

6) Pancreatic Cancer

Pancreatic cancer affects about 1 in every 71 persons. According to researchers, around 10 out of every 100 pancreatic tumours are caused by a cancer gene flaw (10 percent). Despite the fact, that it appears to run in families, scientists have yet to discover a specific gene flaw that causes it, hence there is no test available at this time.

When several types of cancer occur in the same family, cancer of the pancreas might emerge as the part of family cancer syndromes. Other types of cancer, as well as pancreatic cancer, linked to the genes indicated here.

7) Womb Cancer

In general population, about 2/100 women (2%) may acquire womb cancer over their lifetime. Womb cancer affects between 40 and 60 out of every 100 women (40 to 60 percent) who have Lynch syndrome. Defects in the MLH1, MSH2, MSH6, and PMS2 genes cause Lynch syndrome. It also raises the chance of a variety of other malignancies, such as bowel and ovarian cancers. A defective PTEN gene is another gene that raises the chance of womb cancer. Cowden syndrome is an uncommon disorder in which this gene is defective.

8) Thyroid Cancer

Thyroid cancer affects a large population each year. Thyroid cancer can manifest itself in a variety of ways. The most prevalent type of thyroid cancer is papillary thyroid carcinoma, is rarely caused by inherited genes which are defective.

9) Eye Cancer

Eye cancer is a rare type of cancer that mostly affects children under 5. A population of children are diagnosed with eye cancer each year. This malignancy affects the retina, which is the portion of the eye which detects light and colour. A defective gene called RB1 is inherited by about 40 out of 100 children who develop retinoblastoma (40 percent). The reason of the remaining 60 cases (60 percent) remains unknown.

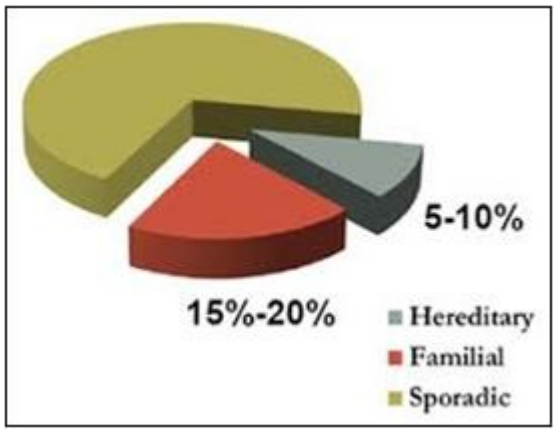
10) Skin Cancer

Melanoma (skin cancer) affects approximately 15,400 people each year. Melanoma is caused by too much UV light, which can get from the sun or artificial sources like sun beds. Melanoma affects about one out of every ten persons (10%), with a family history of this disease.

Hereditary Cancer Syndrome

Inherited genetic alterations play a significant influence in approximately 5 to 10% of all cancers. More than 50 hereditary cancer syndromes, which are illnesses that may predispose people to various cancers, have been linked to mutations in specific genes by researchers. Hereditary cancer syndrome genetic tests can be used to determine that, if a person from a family with symptoms of the syndrome carries one of these mutations or not. These tests can also reveal whether family members who don't have any symptoms inherited the same mutation as a family member who has a cancer-linked mutation. When someone has a personal or family history that suggests an inherited cancer risk condition, many experts recommend, the genetic testing for cancer risk be considered, as long as the test results can be interpreted (that is, they can clearly tell whether a specific genetic change is present or not) & result provides information that will help guide a person's future medical care.

Cancers that aren't caused by inherited genetic abnormalities can appear to "run in families" in some cases. Family members may get comparable cancers as a result of common environment or lifestyle, such as use of tobacco. Certain types of pattern in the family, that develop cancer, the prevalence of various non-cancer illnesses, and the ages at which cancer begins, may indicate the presence of a hereditary cancer syndrome (HCS). Even if a cancer-predisposing mutation runs in a family, it doesn't mean that everyone who gets it will get cancer.



Testing for Hereditary Cancer

A person's doctor, or the other health care provider will normally request genetic tests for mutations that cause hereditary cancer syndromes. Genetic counselling can assist individuals in weighing the risks, advantages, and limitations of genetic testing in their specific circumstances. A genetic counsellor, doctor, or other health care professional with genetics training can assist an individual or family in understanding their test results and explaining the prospective consequences for other family members.

People considering genetic testing should be aware that their results may be shared with other people or organisations with genuine, legal access to their medical information, such as their insurance company or employer, if the patient's health insurance is provided as a benefit by their employment.

Risk Factors for Hereditary Cancer

A type of cancer produced by an inherited gene mutation is referred as hereditary cancer. An inherited gene is one that is passed down through the generations from one parent to the next.

The following factors suggest a possible increased risk for hereditary cancer:

1) **Family history of cancer-**
   Having three or more relatives with the same or related cancers on the same side of the family.
2) **Cancer at an early age-**
   Having two or more relatives, diagnosed with cancer while they were young. Depending on the type of cancer, this component may vary.
3) **Multiple cancers-**
   When a family member is diagnosed with two or more cancer kinds.
4) **Rare cancers-**
   Inheritance of genetic mutations have been related to the cancers such as ovarian cancer, adrenocortical cancer, and sarcoma.

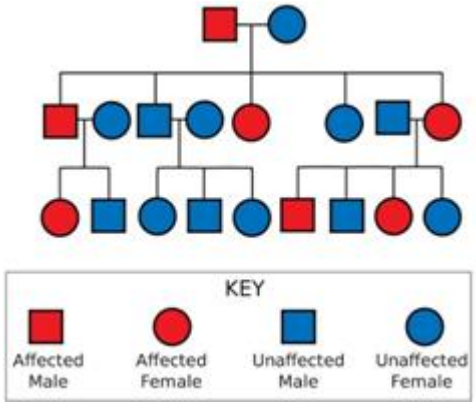
Diagnosis of familial cancer syndromes

Whenever there's suspicion of a family cancer-prone condition, the primary care physician is generally the first to use cancer genetics to clinical care. Based on gene function knowledge, it would be just impossible to anticipate which mutations cause which familial cancers.

Pattern recognition and linking to known mutations are used to make diagnosis. Recognition of familial patternsq of disease may lead to additional examination of individuals and families who may be impacted. The goal will be to provide excellent screening and management advice.

Examples of common familial cancer syndromes-

- In the Li-Fraumeni syndrome, sarcomas, breast malignancies, brain tumours, leukaemia, lymphoma, and adrenal cortical tumours all have p53 mutations.
- BRCA1/BRCA2 mutations in breast and ovarian cancer (the hereditary breast and ovarian cancer/HBOC, syndrome).
- Cancers of the colon, endometrium, ovary, stomach, pancreas, and other organs with DNA MMR mutations in LS.
- In Hereditary Diffuse Gastric Cancer (HDGC) Syndrome, CDH1 mutation causes diffuses gastric cancer & lobular breast cancer.



Treatment

Although genes have a part in cancer risk, genetics can also play a role in search for an effective therapy. Researchers have tapped into a variety of genetic resources and discovered several treatment options in pharmacogenetics as well as a variety of gene therapy variations.

Current treatment

Chemotherapy & Surgery, are the most prevalent cancer treatments nowadays. Chemotherapy is ineffective because it does not specifically target cancer cells. Chemotherapy focuses on dividing cells since cancer cells are constantly dividing abnormally. This is known to have a slew of negative consequences. When bone marrow cells are eliminated, patients experience hair loss, exhaustion, and a weakening of the immune system, among other side effects. Because the immune system's power is so important throughout recovery, these side effects have a significant impact on patient recovery.

Chemotherapy can harm reproductive organs and cells, resulting in infertility and long-term reproductive issues. Chemotherapy not only destroys good cells alongside malignant cells, but it also ignores genetic variances between people and the resulting variations in people.

Pharmacogenetics

The notion of pharmacogenetics must be recognised in order to increase the benefit-to-harm ratio of chemotherapy. To

improve drug response, pharmacogenetics includes tailoring treatment to an individual's genetic traits. One expects that all chemotherapy dosages will be fine-tuned to account for a person's metabolic mutations, diminished functions, and other factors, ensuring that the patient obtains more effective dosage for his or her condition & the tumor's genetic roots are also targeted.

Patients with the SULT1A1 gene, for example, would receive a higher dosage to compensate for fact, that the body can only metabolise 25% of the dose eaten. Iressa, a medication that has shown to be particularly beneficial for lung cancer, is currently being studied in Japan. The medication was quite effective at reducing tumour growth. It has worked so successfully, in fact, that the usage of this medicine has recently been approved in USA & Australia.

Gene therapy

Several cancer gene therapy studies are currently being developed. One of these efforts featured a team of researchers from Shanghai Second Medical University successfully inserting a gene into human tumour cells through a retrovirus, as served in Chinese Medical Journal (2002). Antigens present on surface of tumour cells usually distinguish them from normal cells. Noncancerous cells that are similar to cancerous cells possess these antibodies as well, but at a much lower level. As a result, in the presence of cancer cells, the chances of the retrovirus adhering to a noncancerous cell are slim.

Researchers discovered that the corrected gene can be incorporated into the timorous cell, and that the retrovirus stays away from normal cells in the majority of cases. At the moment, gene therapy is carried out by the retrovirus that has been designed to deliver a single gene.

3. Future

Cancer genetics is a vast and lucrative field of study. A huge number of cancer genes have been found and characterised throughout the last several decades. This has resulted in better genetic testing and diagnoses, as well as more accurate prognostic information; developments in cancer genetics are only now beginning to make some impact on cancer therapies. The Human Genome Project's upcoming complete sequencing of the human genome, combined with additional breakthroughs in techniques such as microarray expression analysis, will drastically accelerate progress in cancer genetics research.

Once chromosome breakage sites have been discovered, the known genes that reside at that precise chromosomal position can be easily cloned. The completion of the Genome Project, on the other hand, will greatly ease descriptive investigations, as well as the identification and cloning of specific cancer-related genes. Mechanistic tests to uncover the molecular foundation by which specific genes aid carcinogenesis will continue to be required, and will likely get more difficult as the amount of background genetic information available grows.

Furthermore, the ability to explore gene expression patterns involving tens of thousands of different genes at the same time will necessitate novel experimental design approaches. These advancements should make cancer genetics more enticing to researchers since they will be able to spend less time finding the parts and more time attempting to fit the puzzle together.

4. Conclusion

Cancer genetic screening is crucial for determining cancer susceptibility as well as choosing the optimal therapy choice for cancer patients based on their tumour genetic profile. Several genetic tests are used in clinical practise to evaluate the susceptibility to and treatment of common cancers that strike Western populations, such as breast and ovarian cancers, CRC, and lung cancer.

The competency of the laboratories and medical staff performing the genetic screening, the argument of individual rights vs collective rights, the issue of distributive and environmental justice, discrimination, and stigma are all ethical concerns associated with cancer genetic screening.

Everyone could profit from medical research and developments in testing technologies if these ethical considerations are addressed in the deployment of cancer genetic screening in populations. Cancer genetic screening will aid health care practitioners in their attempts to prevent cancer, in closely monitoring individuals, and in deciding on which are best treatment options for precision medicine in the future together.

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