Case Study: Genomics and Cancer

Joe has just returned home from the doctor's office where he was diagnosed with breast cancer. Joe is a 45-year-old genetic (XY) male with three kids (2 genetic (XX) females and 1 genetic (XY) male). Once Joe's oncologist, a doctor specializing in cancer, discusses Joe's diagnosis with him he recommends that Joe sees a genetic counselor to investigate a potential hereditary component of his cancer. His oncologist also begins to plan Joe's cancer treatment with him, as well. Breast cancer is rare among genetic males. Less than 1% of breast cancer diagnoses are in men (Terando et al. 2015). Of that 1%, the BRCA2 mutation causes up to 14% of these cases (Couch et al. 1996).

The following week, Joe meets with a genetic counselor that focuses on cancer. Joe's oncologist recommended Joe meet with a genetic counselor because a genetic counselor can assess Joe's risk of having hereditary cancer through his family's health history. Genetic counselors can offer genetic testing to clients who seem to be at high risk for carrying a disease-causing mutation. As the genetic counselor records Joe's family history, he realizes that a significant amount of people in his family have been sick with cancer. Several of Joe's genetic female relatives have had breast or ovarian cancer. The genetic males in Joe's family have also battled other cancers such as pancreatic and prostate cancers. The genetic counselor is concerned with the prevalent history of breast and ovarian cancer, especially since Joe has also been diagnosed with breast cancer. The genetic counselor tells Joe that he may carry a BRCA2 mutation, which is a mutation which puts those who have it at high risk for breast and ovarian cancer. This mutation can be passed down through families. Joe is offered a test to see if he has a mutant version of BRCA2. The genetic counselor reminds Joe that there are many things

to consider before he accepts or rejects the test. If Joe possesses the cancer-causing mutation, he may have passed this down to his children. It could also mean that his siblings, parents, aunts, uncles and other family members could also possess this mutation. These people may or may not be interested in knowing this information.

In the following weeks, Joe received a call from the genetic counselor to discuss the results of his genetic test. The test reveals that Joe does not possess a BRCA2 mutation. Instead, the sequencing test showed that the mutation causing his breast cancer is in the HER2 gene. The HER2 gene encodes a protein growth factor (Tandon et al. 1989, Ahn et al. 2020). To treat Joe's specific cancer with the highest likelihood remission, his oncologist recommends a precision medicine approach. This means that they would consider the mutation that is causing Joe's cancer and center the drug treatment around this information. The drug, Herceptin, is known to be effective against Joe's type of cancer (Verma et al. 2012). Herceptin is an immunotherapy treatment, which destroys the cancer in a different manner than traditional chemotherapy.

Discussion Questions:

1. What are some methods that could have been used to identify BRCA2 as a gene highly associated with the incidence of breast and ovarian cancer?
2. What type of sequencing techniques are used to determine if Joe has a mutation in the BRCA1 gene?

3. Originally, the genetic counselor suggested testing if Joe had the mutation in BRCA2, but reported a mutation in HER2. What genomic techniques would result in testing beyond a single gene?
4. Should Joe's children be screened for the BRCA2 mutation?
5. What treatment plan would you recommend for Joe? The precision medicine immunotherapy drug, or traditional radiation and chemotherapy? Or both?
6. Now that Herceptin has been proven to greatly improve the prognosis for patients with HER2 positive tumor, do you think it is important to continue to develop other drug therapies to treat HER2 positive tumors? Why or why not?
7. What other social or ethical concerns should the genetic counselor discuss with Joe about undergoing genetic testing?

References

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