

Including Antibodies in Cancer Treatment

By Wills Levy

When I was growing up, we called the entryway to my house the “DMZ”- the decontamination zone. As soon as I walked through the front door, I would be greeted by my parents, who helped me strip my shoes, socks, and clothes off before I ran immediately to the sink to wash my hands; then I would sprint to the shower. This was the drill every day when I got home from preschool. While most kids upon returning home would be greeted with a snack and a hug from their parents, this was distinctly not the case for me, but I understood why we did it: my brother had cancer.

My brother had been diagnosed with leukemia, and so I knew that this seemingly paranoid routine was the only way to keep him healthy. Ironically, the treatment for his leukemia, chemotherapy, was the very reason we were forced to undergo the whole process every time we came home. During chemotherapy, the widely used treatment for cancers including my brother’s, toxins are sent into the body to destroy many cells, with the goal of eradicating the cancer cells in the body before all healthy cells are destroyed. However, as Hussain Attarwala notes (2010), chemotherapy lacks specificity in being able to determine which cells are cancerous and which cells are healthy, meaning that it kills both malignant and healthy cells at equal rates. As one can imagine, losing significant amounts of body cells can lead to problems, visibly evidenced as the body experiences hair and weight loss, resulting from drops in hair, muscle, and bone cell counts. However, some of the most valuable cells you have in your body beyond those performing functional tasks are your immune cells, among them the B cells that produce antibodies, which were found to drop up to 25% in children undergoing chemotherapy, depending on the antibodies’ target disease. (Reinhardt et al., 2003)

Losing Your Antibodies

Losing your antibodies can wreak havoc upon the body: your antibodies are your first line of defense against foreign pathways, the figurative trumpet warning the city of your body that a foreign invader has entered. Each ‘Y’ shaped antibody specifically builds the branches of the ‘Y’ to attach to a specific antigen, a protein on the surface of the intended pathogen. As a result, each specific antibody is able to recognize and alert the body when a specific pathogen enters, allowing natural killer and phagocyte cells to dispose of the pathogen. When one loses their antibodies, they lose their capability to quickly identify and target pathogens, making it extremely difficult to defend oneself against viruses, even relatively harmless ones. For cancer patients devoid of most of their antibodies like my brother, this means that a common cold could be fatal: a study done in the Journal of Infectious Diseases and Therapy found that cancer patients experience a mortality rate of infections 3 times higher than that of a healthy person.

(Zheng et al., 2021) Hence, my brother couldn't get exposed to any pathogens at all; an extremely difficult task given the intense exposure to pathogens that characterizes one's childhood like my own. My parents were forced to literally be my brother's "out of body antibodies", identifying myself and my clothes as potentially containing pathogens, and as a result eliminating the pathogens with soap, bleach, and a laundry machine.

As if the accidental suppression of antibodies through cancer treatment wasn't enough, other treatments of cancer can sometimes include immunosuppressants, destroying one's immune system, the only option to keep them alive. Because chemotherapy is unable to be precise in treatment and often leaves debilitating side effects, cancer patients have to turn to other treatment options such as a bone marrow transplant. During my brother's battle with cancer, I donated my bone marrow to him, a final treatment option to keep him alive. While the bone-marrow transplant worked, providing his body with invaluable healthy stem cells and leading him to a temporary remission, this process also involved him being given immunosuppressants, drugs that suppress and weaken the immune system. Without immunosuppression, his body would reject the potentially lifesaving bone-marrow, but the weakening of his immune system made his body further susceptible to pathogens. As a result, he had to stay in a unit of the hospital kept sterile, free of pathogens but also free of children. I was unable to visit him while he was in that wing of the hospital, as only my parents could visit him, themselves needing to go through an extensive sanitation process. Instead of visiting him, I would go to the ground-floor window of the hospital and look at him through the window, talking over a cell phone as I stood there. The glass window, maybe half of an inch thick, separated my hand and my brother's; however, beyond separating familial bonds, it also acted as a barrier between a world filled with pathogens and one where one pathogen could prove fatal.

Promises of Antibody-Assisted Cancer Treatment

What if we could live in a world where a strong glass window didn't need to separate dying cancer patients from their siblings, in a world where the cancer patients could survive and thrive without experiencing extensive drops in antibodies? That is the possibility that antibody-assisted cancer treatments provide cancer patients.

The general premise of antibody-assisted cancer treatments is that an antibody uses its variable region, the "branches" of the Y, to recognize antigens on the surface of cancer cells, allowing the body or a treatment to specifically target cancer cells themselves. A lack of specificity in treatment is one of the reasons chemotherapy's success is limited: chemotherapy doesn't target just cancer cells, meaning that chemotherapy's toxicity must be lowered in order to not decimate the body more than it already does, hindering its effectiveness at killing malignant cells. However, if one

combines toxins like those commonly used in chemotherapy with an antibody trained to recognize cancer, the antibody can effectively target only the cancerous cell without damaging benevolent cells. (Attarwala, 2010) Beyond just chemotherapy, we can bind antibodies to radioactive payloads, toxins, drugs, or even RNA that interferes with the genes of cancer cells to prevent replication of malignant cells, abbreviated as siRNA. The potential for siRNA is immense, as research found that a binding between an antibody, the siRNA, and another protein was able to silence genes in some breast cancer. (Song et al., 2005) In addition to the capabilities of lab-made antibodies in cancer treatment, our bodies even have some natural antibodies to cancer (Vollmers and Brandlein, 2009). Potential future research in the field of antibodies could lead to enhancement of these natural antibodies to be able to target and kill malignant cells when a tumor or the bloodstream become cancerous.

Conclusion

While antibodies currently haven't cured cancer, they have made remarkable success in recent years, and their promise renders the continuation of current research paramount. For each toxin and treatment linked with antibodies I mentioned previously, researchers are investigating the potential structures and variations of the antibody that achieve the goal of stopping multiplication of malignant cells while not triggering an immune response against the injected antibodies themselves. Eventually, with continued research, we could see the day that we *shatter the glass windows* separating cancer patients from the outside world, allowing cancer patients to have their cancer eradicated while they live at home with their families, free of the devastating effects chemotherapy has on the immune system and one's body. I was forced to come home from preschool to parents wearing masks and holding a sanitizer bottle, my brother being treated miles away at the hospital. By supporting research of antibodies in cancer treatment, we can make it possible for kids like myself to come home to not just a snack and a hug, but a brother.

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