Infection and immunology: a case study

The presenting symptoms for Billy DeWitt were his consecutive infections of sinusitis, otitis media and pneumonia. All of these infections were bacterial in nature and as such they were treated successfully with antibiotics. A further physical examination revealed that the child does not have palantine tonsils. This is considered a symptom as he has not had them removed at any point surgically. This implies that he was born without those particular tonsils, which may be characteristic of what is ailing Billy. The final two symptoms involve the analysis of Billy's blood. The tests showed that the blood contained one-fifth what is considered the regular level for immunoglobulins and also that the concentration of B-lymphocytes was down. The blood tests also showed that the functionality of Billy's T-lymphocytes was within normal limits. This means that although the some of the immune response is normal, the amount of both immunoglobulins and the B-lymphocytes in the blood serum were low. This suggests that the disease that Billy has seems to be affecting a specific part of his immune response.

The inflammatory response is the body's natural response to tissue damage. The four basic signs for this response are pain, swelling, fever, and lethargy, apathy, and a loss of appetite.

There are two stages to pain. First is the acute pain that is caused when you do something such as touch a stove. It's a quick stabbing-like mechanism that tells the brain that you are doing something that's not good and gets you to stop it immediately. The latter type of pain, the type seen with inflamation, is the kind that stays for a long time. It acts as a constant reminder to take better care of the area in order for it to heal

Swelling is a defensive process created by the body. The sensory nerves react to what is causing the inflamation and causes the blood vessles to become more permeable (causing redness). This causes the white blood cells to get out to where the problem is and attack any pathogens that are causeing it.

Fever is caused by an increase in the hormone prostaglandin E2, which causes the hypothalmus to increase the body's " thermostat." This makes the external temperature feel colder, causing the body to go through invouluntary actions to increase body heat, such as shivering. Also, most bacteria reproduce the most at normal body temperature, so by increasing the temperature of the body, the bacteria divide less often. This is also convenient because at a higher than normal body temperature, immune cells divide faster.

The root cause of the lethargy, apathy, and loss of appetite seen in someone responding from inflammation, is their fever. In order to cause a fever, the body must use up 10-13% more body heat than usual, which requires much more energy. In order to balance the " energy budget", sacrifices must be made elsewhere, causing the person in which the infection is located to be more lazy and tired, because they lack energy.

" Inflamation and tissue Healing" Sportsinjuryclinic. net. Web. 4 Feb. 2010.

Quanted, Patrick. " The inflammation Process". Web. 4 Feb. 2010.

The body is populated by two types of lymphocytes: B- and T-lymphocytes. Both types of lymphocytes circulate through the blood and lymph and are

concentrated in the spleen, lymph nodes, and other lymphoid tissues. B cells and T cells recognize antigens by means of antigen receptors embedded in their plasma membranes. A single B or T cell bears about 100, 000 of these antigen receptors, and all the receptors on a single cell are identical – this is, they all recognize the same epitope. In other words, each lymphocyte displays specificity for a particular epitope on an antigen and defends against that antigen or a small set of closely related antigens.

T cells and B cells are the major cellular components of the adaptive immune response. T cells are involved in cell-mediated immunity whereas B cells are primarily responsible for humoral immunity (relating to antibodies). The function of T cells and B cells is to recognize specific “ non-self” antigens, during a process known as antigen presentation. Once they have identified an invader, the cells generate specific responses that are tailored to maximally eliminate specific pathogens or pathogen infected cells. B cells respond to pathogens by producing large quantities of antibodies which then neutralize foreign objects like bacteria and viruses. In response to pathogens some T cells, called T helper cells, produce cytokines that direct the immune response while other T cells, called cytotoxic T cells, produce toxic granules that induce the death of pathogen infected cells. Following activation, B cells and T cells leave a lasting legacy of the antigens they have encountered, in the form of memory cells. Throughout the lifetime of an animal these memory cells will “ remember” each specific pathogen encountered, and are able to mount a strong response if the pathogen is detected again.

Harding, CV, and L. Ramachandra. “ Presenting exogenous antigen to T cells.” PubMed. gov. U. S. National Library of Medicine National Institutes of

Health, Feb. 2010. Web. 10 Feb. 2010.

Lee, K, et al. “ In Vivo Tumor Suppression Activity by T cell-specific T-bet Restoration.” PubMed. gov. U. S. National Library of Medicine National Institute of Health, 8 Feb. 2010. Web. 10 Feb. 2010.

A person with deficient of B-Cell will have weak immune responses since the B cell are responsible for the primary immune response. This will lead to massive bacterial infection early in life during development. Typically respiratory infections such as pneumonia are usually the first sign of these infections. Others are skin infections; meningitis, bacteremias and abscesses are also common when there is a deficiency in B-Cell. The deficiency of B-Cell usually occurs when the child becomes 7-9 years of age. Tonsillar B-Cell is the primary type of B cell which is produced by the pansil tonsil located in the side of throat. Since Billy lacked the palatine tonsils, the onset of B-Cell problems would therefore occur much early in his life.

Issam, Makhoul. “ Pure B-Cell Disorders.” emedicine. Medscape, 4 Nov. 2009. Web. 10 Feb. 2010.

Antibodies (also known as immunoglobulins, abbreviatedIg) are glycoproteins that are found in blood and other bodily fluids of vertebrates. They are used by the immune system to identify and destroy foreign objects (bacteria and viruses). Plasma cells, a kind of white blood cell produce antibodies. Antibodies have a similar structure but have a small region at the tip of them that allows millions of antibodies with different tip structures and antigen binding sites, to exist. They are Y-shaped with a binding site on each tip of the Y. This region is known as the hypervariable region. There are five

classes of antibodies: IgG, IgA, IgM, IgD, and IgE. IgG are the most important antibody and also the most common. Each antibody can bind to a specific antigen using its tip. An antigen is any substance that causes the immune system to produce antibodies against it. Antigens can be a foreign substance such as a bacteria, virus, chemical, toxin, or pollen. The large amount of antibodies allows the immune system to recognize many different antigens and act accordingly. The unique part of the antigen recognized by an antibody is called anepitope. Epitopes bind with their antibody in a process calledinduced fit. This allows antibodies to identify and bind only to their specific antigen. Antibodies can also destroy targets by binding to a part of apathogenthat it needs to cause aninfection. Antibodies function in different ways designed to eliminate the antigen that caused their production. The binding occurs by noncovalent forces, like between enzymes and their substrate. These bonds include hydrogen bonds, electrostatic bonds, Van der Waals forces and hydrophobic bonds. When a foreign object enters the body for the first time the body can develop symptoms of disease. After the same antigen enters the body again the body develops an immune response to that pathogen. This is the way people avoid certain diseases such as chicken pox more than once.

“ Antigen Presentation.” Kimball’s Biology Pages. N. p., 30 Aug. 2009. Web. 10 Feb. 2010.

Mayer, Gene. “ Immunoglobulins – Structure and Function.” Mircrobiology and Immunology On-line. University of South Carolina School of Medicine, 6 Nov. 2009. Web. 10 Feb. 2010.

Stevenson, John R. “ Immunoglobulin Structure and Function.” MBI. N. p., 19 Sept. 2008. Web. 10 Feb. 2010.

Ten months is the normal age at which babies are weaned. If this is what happened to Billy, then it explains why he was never infected before. Breastfed babies are protected by their own mother’s milk. About 80 percent of the cells in a mother’s milk are macrophages, which kill bacteria and viruses in the baby’s body. Not only that, but the mother’s milk also contains antibodies for whatever disease is present in her environment. This protects the babies from many diseases such as pneumonia, staph infections, and ear infections. Weaning Billy from his mother’s milk takes away the only protection from his environment that he has, because his body is incapable of fending for itself, and leaves him defenseless, which causes him to constantly get sick.

Williams, Rebecca D. “ Breastfeeding: Best Bet for Babies”. Childbirth Solutions, Inc. Web. 8 Feb. 2010.

The palatine tonsils, also referred to as tonsils, are a pair of very elastic tissue masses located at the back of the throat, which is the pharynx. Each of these tonsils is made of tissue that is similar to lymph nodes covered in pink mucosa. The palatine tonsils are part of the lymphatic system. The lymphatic system fights off major and minor infections. They are the body’s defense against viruses and bacteria by creating antibodies to destroy the bacteria or virus. Medical researchers have studied that when children’s tonsils are removed, they would not suffer the loss in the future with immunity to diseases or the ability to defend off infections. In humans,

tonsils vary in size and swell in response to infections. The tonsils are a common site for infections and when they are inflamed, the condition is known as tonsillitis. The surgical procedure of the removal of the tonsils is known as tonsillectomy.

“ tonsil.” Encyclopædia Britannica. 2010. Encyclopædia Britannica Online. 10 Feb. 2010

“ Understanding Tonsillitis – the Basics.” WebMD. N. p., 25 Nov. 2008. Web. 10 Feb. 2010.

The fact the Billy had two uncles that died as young children suggests that they have a disease that is linked to the X chromosome. The article says nothing about the child’s grandfather having any problems, which means that the disease cannot be on the Y chromosome. The mother is healthy, therefore women are the carriers of the gene and Billy’s mother passed it onto him. The reason that his mother does not have the disease is because women have two X chromosomes. As long as she has one healthy X chromosome she will not have the disease.

The disease that we believe that Billy DeWitt has is X-linked agammaglobulinemia. This disease fits almost all of the symptoms very well. This disease is a genetic disease that is on the X chromosome and it results in the person lacking immunoglobulins because the majority of their B-lymphocytes do not develop properly. This is completely consistent with tests done on the Billy’s blood serum with his immunoglobulin levels and B-lymphocyte levels both being down. This disease also leaves the T-lymphocytes untouched which matches the results that said the T-

lymphocytes in Billy’s blood were functioning properly. This diagnosis also explains why Billy had bacterial infections as a baby. B-lymphocytes are important in fighting off bacteria and because he did not have as many it makes sense that he would be much more susceptible to those types of diseases. The only thing that is slightly inconsistent is the child’s lack of palatine tonsils. Symptoms of this disease include lymph nodes like the tonsils as being extremely small because they usually house B-lymphocytes, but it does not say that any patients completely lacked palatine tonsils from the disease. It is possible that they were so small that the doctors missed them because they were so small, or it is just a coincidence that they were never there and it did nothing but augment the disease by taking away a possible place of B-lymphocyte creation.

This disease cannot be completely cured because it is genetic but the symptoms can be managed. Billy needs to receive a steady supply of a mixture of immunoglobulins and antibodies for many different diseases. This will allow him to maintain his immune system at a higher level and allow him to live a pretty normal life. The only thing that really needs to be avoided is any kind of live viral vaccines. People with X-linked agammaglobulinemia tend to contract the viruses that are meant to be prevented from the vaccines because of their weakened immune systems.

International Patient Organisation for Primary Immunodeficiencies. X-Linked Agammaglobulinemia. Immune Defiency Foundation, 2007. PDF file.