Stopping the Silent Killers:

The Discoveries that Changed Medicine in War

Before World War II the majority of fatalities in war were not caused by trauma but by diseases. Common diseases like dysentery, cholera, typhus, typhoid fever, smallpox and the influenza would wipe out entire camps of soldiers before bullets were ever fired. WWII marked the transition to trauma causing the most fatalities. Trauma wounds are defined as an injury to living tissue caused by an extrinsic agents like bullets, shrapnel, or blunt force injuries. Medical advances with blood transfusions, vaccines, and antibiotics caused a shift from infection being the most significant cause of combat fatalities to trauma causing the most deaths.

Modern military history from a medical perspective can be divided into two eras, the Infection Era and the Trauma Era. The Infection Era began in 1775 and continued until 1918.[1] This era was characterized by fatalities as a result of infectious diseases. Diseases weakened troops and increased their vulnerability in battle. According to military hygienist Alfred A.Woodhull "the sick are for the time as ineffective as the dead."[2] Disease spread rampantly throughout over crowded camps in which there was a lack of sanitation and disposal of wastes. Soldiers and doctors practiced poor hygiene, which helped spread disease. On average the infectious deaths to combat deaths was 4.34:1 between 1775 and 1918. The highest ratio occurred during the War of 1812 in

[1]Vincent J. Cirillo, "Two Faces of Death fatalities from disease and combat in Americas principal wars, 1775 to present," Perspectives in Biology and Medicine 51 (2008) 121.

[2]Cirillo 125.

which there was a ratio of 7.5 infectious deaths to each combat death. WWI was the final stage of the infection era. An average of 1.1 infection deaths to each combat death occurred. Infection claimed the lives of 15% of all wounded Americans. [3]The end of this war was marked by one of the most historical infections, the 1918 influenza pandemic. This flu outbreak covered the entire world and spread rapidly throughout the armies in WWI. It quickly wiped out 40 million people including a significant number of soldiers.[4] Historical documents confirm that the armies were aware of the significance of the outbreak.[5] However, without modern medicine and treatment there was little anyone could do.

The Trauma Era began in 1941 and continues today. This presented a shift in which significantly more soldiers died from battle injuries than infections. The weaponry between WWI and WWII did not drastically change. The similar bullets and shrapnel in these wars resulted in the same amount of trauma.[6] One would expect the fatality rates to be comparable. However, the differences in the fatality statistics are drastic. By the end of WWII only .06 soldiers died from infection to each combat related death. Around this same time three major medical advances were developed that would change the future of medicine and war.

The first major advancement in medicine was vaccines. They are weakened or dead

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[3]Carol R. Byerly, Fever of War The Influenza Epidemic in the U.S. Army During World War I (New York: New York UP, 2005) 132.

[4]Neil A. Campbell and Jane B. Reece, Biology (8th Edition) (San Francisco: Benjamin Cummings, 2007) 392.

[5]B. M. Eurwood, "Air Service, United States Army Telegram." Letter to Adjutant General of the Army Washington, D.C. (The National Archives, Chicago, Illinois16 Oct. 1918)

[6]Norman M. Rich, and David G. Burris, "Military Surgery: 19th Century Compared with 20th Century." American College of Surgeons (2004) 321-22.

strains of viruses that are injected into the body. These weak viruses would allow the body to become immune to the full strain of the infectious disease by producing antibodies. Vaccines were originally developed in China around 200BC to treat smallpox.[7] The Chinese would grind a scab of a smallpox survivor and inhale the dust to create immunity to the disease. Arabs further developed this practice. They would insert a scab into a small incision on a patient's arm.[8] As a result of trade these ideas spread to England in 1715. It took over two centuries to finally develop a method in which immunizations could be administered on a large scale. Louis Pasteur developed the modern vaccination method in 1880 that would serve as a model for future vaccinations with his invention of the rabies vaccine.[9] Mass vaccinations of troops did not begin until World War II. The United States and Britain inoculated troops against typhoid fever, smallpox, yellow fever, cholera, plague, typhus and tetanus. In 1927 Harvard University and the Rockefeller Foundation Laboratory in New York City developed a live form of the Yellow Fever Vaccine.[10] After clinical trial the vaccine was deemed so successful that in 1940 the US Army required all servicemen in the pacific to receive the new Yellow Fever Vaccine. Cutler, who was the chief surgical consultant in the European theater, alleged the new vaccinations gave troops protection against diseases that once would have posed a severe threat to soldiers.[11]

A second medical advancement that revolutionized health care was blood transfusions. Blood consists of four main parts: red blood cells, white blood cells,

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[7]Meyer Friedman, Medicine's 10 greatest discoveries (New Haven, Conn: Yale UP, 1998) 171.

[8]Friedman 66.

[9] Patrice Debre, Louis Pasteur (Baltimore: Johns Hopkins UP, 1998) 509.

[10]Cirillo 128.

[11] Cirillo 128.

platelets, and plasma. Blood transfusions are the transfer of one or more of these components from one individual to another. Blood transfusions were invented approximately 200 years ago. [12] At the advent of transfusions they had a 50% mortality rate. At first this was thought to be a result of infectious disease; however, later research showed that the deaths occurred too soon for them to be a result of infections. It was not until 1909 that Karl Landsteiner discovered blood types. Landsteiner discovered that blood cells carry antigens that create the major blood types of A, B, AB, and O.[13] These antigens are markers that tell the body that the blood is not foreign.

Up until the early 20th century blood transfusions were not practical on the battlefield because blood could not easily be stored. When blood is stored it coagulates, which means the blood cells clump up and become unusable. Two important discoveries were made in 1915 that allowed blood to become portable. In the first discovery at Mt. Sinai Hospital in New York City, Richard Lewisohn found that anti-coagulates like sodium citrate prevented the blood from clumping together.[14] The second discovery was that blood could be refrigerated to prevent breakdown. Without these two significant breakthroughs it would be impossible for blood transfusions to be used in war. These discoveries led up to the creation of the first Red Cross Blood transfusion service in 1926 in Great Britain and the first blood bank hospital in Leningrad Russia in 1932. Blood transfusions were a miracle for war medicine because it allowed surgeons to maintain the

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[12]Harvey J. Alter, and Harvey G. Klein, "The hazards of blood transfusion in historical perspective," Blood 112 (2008) 2616-2626.

[13]Physiology or Medicine 1922-1941 (Nobel Lectures). Chicago: World Scientific Pub Co Inc, 1999.

[14] "Highlights of Transfusion Medicine History." AABB. 12 Apr. 2006. Advancing Transfusion and Cellular Therapies Worldwide. 28 Feb. 2009 <http://www.aabb.org>.

supply of oxygen to the brain after injury and blood loss.[15] WWII was the first war in which blood transfusions were practical.[16]

The last and most significant inventions are antibiotics. They are considered to be the miracle drug of the 20th century. Alexander Fleming invented penicillin in 1928.[17] Fleming was a professor of bacteriology at St. Mary's Hospital Medical School in London. He discovered bacteriolytic agents that destroyed the structures of certain bacteria. He called these agents lysozymes. This was the backbone of his research on penicillin. His discovery was pure luck. While growing staphylococci bacteria he discovered a mold sample contaminating one of the plates. He observed that the bacteria would not grow near the mold sample[18]. He established that specific strains of mold could inhibit growth and create antibacterial substances.[19] It took ten years and the help of Howard Florey and Ernst Chain at the University of Oxford to develop a drug that could be produced and distributed.[20] This new drug prevented infections from forming and treated already present infections in troops that had been wounded or become sick. Penicillin was able to treat almost every camp disease that faced soldiers. The new drug created a massive demand for pharmaceutical companies in Great Britain and the US.[21]

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[15]Norman M. Rich 321.

[16]Basil A. Pruitt, "The Symbiosis of Combat Casualty Care and Civilian Trauma Care," The Journal of Trauma Injury, Infection and Critical Care 64 (2008): S4-S8.

[17]Gladys L. Hobby, Penicillin meeting the challenge (New Haven: Yale University Press, 1985) 3.

[18]Friedman 171.

[19]Hobby 11.

[20]John C. Sheehan, The Enchanted Ring the Untold Story of Penicillin (Cambridge, Mass: MIT Press 1982) 18

[21]Robertson Pratt and Jean Dufrenoy, Antibiotics (Philadelphia: J. B. Lippincott Company, 1949) 18.

By D-day the US was producing 100 billion units of penicillin. This allowed them to treat 40,000 men a month.

The transition from World War I to World War II revealed a dramatic drop in fatalities due to infection. Tetanus, a disease that once had a 20-58% mortality rate in WWI was reduced to .000001% in WWII. There were only 11 cases and 4 fatalities among approximately 11 million soldiers.[22] This dramatic drop coincides with the invention of the tetanus vaccine in 1927 and antibiotics to treat those who contract the disease. Another finding that supports the idea that medical advances resulted in the change of the era was that after the yellow fever vaccine was developed in 1940 not a single US soldier became infected with the disease. The final turning point in which disease was no longer the predominant killer in war was after the allied forces introduced antibiotics on a large scale. After D-Day, which was the height of antibiotic production, allied military deaths as a result of infection were approximately zero.[23] In the wars following WWI the average infectious deaths to combat deaths fell to .028:1. This number is significantly lower then the data from the Infectious Era. Deaths related to trauma are no longer overshadowed by disease. This change highlighted the horrible physical injuries that war inflicts. It has led to an increase in awareness of the impact of cardiovascular and orthopedic trauma.

Medical advances divide military history into two distinct eras, the Infection Era and the Trauma Era. This advances were accompanied by a dramatic shift in the primary cause of death in war from infections to trauma. The weaponry between WWI and WWII did not significantly change; however, major medical breakthroughs occurred within that

[22]Cirillo 128.
[23]Cirillo 129.

time. It is no coincidence that after the discovery of blood transfusions, vaccines, and antibiotics that the rate of infectious related fatalities plummeted.

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