

MEDICAL ADVANCES OF THE WORLD WARS

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ABSTRACT

Throughout the history of warfare, military leaders have recognized the potentially devastating consequences of ailing armies. Outbreaks of disease among the ranks have contributed to the collapse of empires and the falls of dynasties. Even today, we are just one mutation away from catastrophic consequences that would literally reshape the world as we know it. While it is true that the World Wars underscore the capacity of armed conflict among world powers to spread disease on a global scale, they also highlight the medical advances that often accompany modern warfare. Herein, we reflect upon the role of the World Wars in establishing a trajectory for modern medicine and posit an organizational role for our armed forces as a platform of cooperation in global public health.

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1. INTRODUCTION

Leo Tolstoy's statement "For it is by those who have suffered that the world is most advanced" articulates the impact of the World Wars on the field of medicine. No direct cause and effect relationship occurs between world events and medical advances. They are, rather, instances of necessity followed by accommodation. Between 1914 and 1945, medicine industrialized to accommodate the masses of casualties associated with the World Wars. It would not be fair to say that either war witnessed more genuinely innovative advances in medicine. They both contributed to significant developments related to distinct clinical issues and corresponding applications.

Even before World War I, scientific advances in microbiology had begun to transform medicine to manage the pathology of disease rather than focusing on the management of symptoms, alone. For example, Pasteur and Koch investigated bacteria as pathogenic agents of infectious diseases [1]. Macromolecular bacterial investigation posed a novel area of research into diseases and their physiological impacts on the human body. This ultimately led to the widespread use of vaccines. For example, the typhoid inoculation developed by Almroth Wright was used to immunize thousands of British soldiers in anticipation of their exposure to typhoid during the South African Boer Wars [2]. As a result, British troops ultimately entered World War I as the only combatants that were immunized against typhoid. As evidenced by the relative rates of morbidity and mortality associated with infection, the results were immediate and significant [2].

This successful implementation of a vaccination campaign resulted in a new approach to medicine based on the anticipation and prevention of disease. The advent of this concept marked the birth of *preventative medicine*.

From a diagnostic perspective, clinical researchers had also begun developing technology that facilitated the real-time observation of physiological processes. For example, the electrocardiogram (ECG) machine which measures the electrical currents of the heart was invented by Eithoven, Aschoff, Tawara and His in 1896 [3]. With the ECG, physicians observe electrical dynamics of the heart to investigate cardiac abnormalities. Even earlier, Wilhelm Conrad Rontgen developed pioneering uses for X-ray technology in 1895 [3]. This permitted physicians the novel ability to peer inside a living, human body for clues related to the diagnosis of disease. Around the same time, developments in surgical techniques resulted in greater efficacy of surgical interventions. For example, in 1896, physician Ludwig Rehn initiated the use of cardiac sutures [3]. At the onset of World War I, the ballooning technique was gaining recognition as an innovative method for the clinical management of aneurysms [3]. Long before this, anesthetics had revolutionized the field of surgery by accommodating longer procedures [1]. Each of these developments preceded the war and influenced military medicine during the war.

2. DISCUSSION

Trench warfare in the Great War amplified the occurrence of previously rare illnesses based on the

increasingly stagnant and unsanitary fighting conditions. These seemingly new illnesses resulting from the conditions of the trenches posed medical mysteries for military doctors. For example, *Trench Fever* was recognized at the 3rd Corps Medical Society in March 1916 when Lieutenant Colonel B. Soltan presented on the characteristic relapsing fever associated with the disease [4]. Patients presenting with swelling, pain, breathlessness, sore throat or hoarseness were diagnosed as likely candidates of the novel condition of trench nephritis [4]. The poor weather in December of 1914 induced a condition among thousands of troops, termed *trench foot*, associated with protracted immersion in stagnant water [4]. The novelty of trench warfare had resulted in a growing range of symptoms and ailments that had not previously been observed as a widespread condition among armies.

Over the course of the Great War, physicians were granted greater liberty to seek more effective treatments. For example, quinine was prescribed to those with trench fever, natural diuretics given to those with trench nephritis, and frostbite treatment for those with trench foot [4]. While most of these attempts were ultimately ineffective, they created an atmosphere conducive to medical experimentation. For example, Captain H. Oswald Smith found that injecting oxygen into the feet of trench foot victims improved recovery [4]. While amputation for severe cases of gangrene was avoided in favor of less-invasive treatments, over 41,000 men experienced amputations in the First World War, alone [5].

An increasing number of troops buckled under the psychological strain of trench warfare. Even those who appeared outwardly collected suffered stress-induced arrhythmia and angina [3]. Suicide attempts became an increasing occurrence. When taken to the hospital, injuries from these attempts appeared relatively obvious to the nurses and doctors [6]. As if suicide attempts were a contagious disease, the soldier could be shot for cowardice to prevent its spread [6]. Soldiers did whatever they could to avoid returning to the front. Invisible psychological wounds triggered terror in the form of shell shock [5]. The frequency and severity of these cases raised awareness for the necessity of clinical psychological intervention in the military.

World War I represented the first major conflict in which battle wounds caused more casualties than communicable diseases [1]. The bullets utilized in the war made the enemy unfit to fight, but not necessarily mortally wounded. Fatalities from head injuries reached a rate of 11%. If such a patient did survive, the prognosis usually included motor, sensory, language and higher processing deficiencies [7]. About 65% of casualties resulted in impaired motor functions due to locations of bullet and shrapnel penetration [8]. However, bullets were not the only cause of carnage during the war. Mustard gas, likewise, produced serious consequences [9]. Gas gangrene accounted for 12% of mortalities while tetanus accounted for 58% [10].

Shrapnel injuries often tore victims into pieces. In order to reassemble the broken bones, orthopedic surgery became essential to military medicine. Orthopedics became a professionalized specialty because the military had masses of wounded patients needing support and the military had the infrastructure to support the new system [8]. Many techniques developed by orthopedic surgeons

during the war were implemented in surgical practices after the war [8].

Aseptic techniques such as the development of the Carrell-Dakin solution with sodium hypochlorite for washing out wounds, became a life-saving practice in military field hospitals throughout the European theater [10]. New public directorates for hygiene, the development of pathology as a distinct discipline, and the shifting emphasis of public environmental health can all be attributed to World War I [11]. Strict prophylactic discipline eliminated issues such as cholera and typhus from the ranks [12]. In the closing months of the war, inoculations for paratyphoid A and B were readily available among combat units [11].

The method for collecting and treating the wounded in World War I relied upon the coordination of several parties. On the battlefield, bearers collected predetermined zones of wounded, transporting them to the nearest regimental aid post where the Regimental Medical Officer would select to which dressing station they would be sent [13]. Ambulances, usually horse drawn, connected the Regimental Aid Posts and the hospitals and the sheer numbers of casualties overwhelmed the existing medical organization. Therefore, the army developed systems to improve the efficiency of treating the injured troops. For example, medics developed a more efficient way to delegate where men would be going to receive care. The injured were labeled based on the severity of their injuries with either white or red tags [13]. It was also during this time that the twin-table style surgery was developed where one patient was undergoing anesthesia while another was under surgery [11]. Regardless of the saved time, the sheer scale of the war and its associated casualties necessitated the recruitment of more doctors and nurses in the military services [10]. This allowed for the advancement of women into the medical profession. Women assisted in transporting casualties on the battlefield. They even earned the stereotype of being the preferred ambulance drivers because their cautious driving made for a smoother ride [13]. Women were also allowed to operate volunteer organizations, become hospital administrators and initiate the war office notices [2].

New military technologies sparked the development of novel treatments to match the macabre developments. For example, the weaponized airplane in 1916 sparked the development of flight surgeons for the aviation units in 1918 [14]. Complications such as barometric pressures, anoxia, speed, and acceleration of the airplane required engineers and physicians to collaborate to keep the pilots and crews safe [14].

Following World War I, medical technologies continued to advance. The Great War had largely placed molecular scientific research on hiatus. However, such innovations resumed after the war. Although Alexander Fleming discovered penicillin in a bacterial experiment at St. Mary's Hospital in London in 1928 [15], penicillin did not become a clinical asset until Chain and Florey purified the compound in 1940 [15]. Clinical trials for this life-saving antibiotic were initiated in the Royal Armed Forces in 1942 [16]. Penicillin had immediate impacts such that serious infections no longer translated to a death sentence. In concert, Gerhard Domagk synthesized another antibiotic, prontosil, in 1932 [15]. The world of medicine was transforming to include pharmaceuticals as an essential component of treatment. World War II physicians

integrated pharmaceuticals as an essential part of treatment and prevention. Troops were often stationed in regions where malaria was endemic leading necessitating preventative measures such as prophylactic quinine, plasmochin, and atabrine [20]. In 1942, sulphaguanadine emerged as a common therapeutic for the clinical management of dysentery [11]. The pharmaceutical industry continued to grow after the war because of the growing optimism that medicine could cure all diseases [21].

Wound care inventions also improved the overall care of patients. For example, the Director of Surgery at the General Hospital in Barcelona, Dr. Joseph Trueta, developed the *set limb in plaster* technique decreasing the incidence of gangrene among his patients in 1936 [11]. It was also during this time that the psychological health of the patient became a priority concern for military medicine. Common war-associated neuroses included hysteria, obsessive compulsive disorder, anxiety and neurasthenia [11]. The growth of psychology in the First World War allowed for the humane treatment of these patients. Standards of psychological assessment, frequency and treatment of psychological injuries as well as problems with the psychological care of soldiers during the war led to the professionalization of psychiatry after the war [17]. Nations also began to recognize the importance of global health to national security. The League of Nations unveiled the first international health organization charged with investigating epidemiology [18]. Although the dissolution of the League of Nations eventually led to the dissolution of this organization, the precedent was set. Health was now deemed an international concern.

Injuries during the Second World War were commonly associated with blasts. As a result, approximately 70% of injuries during the war were open extremity wounds [8]. Depending on the blast severity, direct hits often resulted in fractures, dismemberment, disintegration, evisceration, ruptured eardrums and more [14]. Shock due to severe injuries emerged as a major concern among medics who observed in an increasing number of demoralized troops who simply lost their will to live [19]. Major hemorrhaging and consequent hypotensive shock made previously experimental blood transfusions a common practice [11].

Unique to the Second World War, the armies applied a new priority focus on the *prevention* of disease [22]. For example, such disease control gave British the advantage in the western desert because fewer casualties resulted from preventable diseases [11]. With a better understanding of infectious disease, the military adapted their procedures to improve the health and morale of troops.

Nineteen new medical units were created out of existing units from World War II to accommodate new medical priorities of the U.S. Military [22]. Of perhaps greatest significance among these, then newly established psychiatry unit focused on prophylactic measures such as medical exam before the enlistment and therapeutic measures such as rehabilitation programs to handle long-term psychological impacts [23].

In considering the progression of the institutionalization of medical specialties across the World Wars, the experiences of the First World War certainly impacted the infrastructure of the Second. The army directorate reorganized to increase clinical staff, include a

psychiatry clinical group, and to establish an Inspector of Medical Services [22]. In the Second World War, Women were recruited as army doctors for the Auxiliary Territorial Service and Blood Transfusion Services [11]. This advancement of women in the armed forces in World War II continued efforts from the First World War to reverse outdated gender biases in a time of crisis. The attitude of medical professionals continued to shift from the First World War to focus on global health. The World Health Organization was founded in 1942 in conjunction with the United Nations [18].

3. CONCLUSIONS

During the Great War, new technologies and new weaponry in combat necessitated the development of novel solutions, treatments and therapies. The conditions of trench warfare presented novel illnesses where physicians relied upon trial and error to develop innovative treatment strategies. These led to innovations in molecular medicine and pioneering new treatment strategies. Together, both the world wars advanced the medical infrastructure and the recognition of public health as a global endeavor. The combined advances leading up to and progressing beyond each conflict established a heightened trajectory for the rapid advancement of medicine and ultimately served as a platform of cooperation in global public health.

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