

Infection and Infectious Disease

US Military Medicine in the Pacific Theater of Operations during WWII

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Abstract:

Infection and infectious disease was a serious threat in World War II. The US war effort in the Pacific Theater of Operations demonstrated how innovations in military medicine could successfully reduce the number of non-battle related injuries and deaths. Penicillin, sulfa drugs, Atabrine, DDT, blood plasma, Morphine and reforms in hygiene and sanitation all played a major role in fighting infection and infectious disease. War in the Pacific tested the capabilities of military medicine and resulted in numerous breakthroughs that revolutionized healthcare in the public and private sectors. The lessons learned from previous conflicts were applied during WWII and resulted in record low mortality rates from infection and infectious disease.

Introduction:

WWII is the largest war in the history of the world. The countries involved spanned the globe and the mobilization that accompanied the war effort was massive. WWII spurred a revolution in industry and technology that changed the world. Much of this change was seen in the field of medicine and public health with the development of the revolutionary antibiotic, Penicillin, and insecticides like DDT. Along with technological advances came the restructuring of military medicine with strict protocols designed to keep troops in the best physical condition possible. A better understanding of how to significantly reduce the non-combat threat from infection and infectious disease made WWII the first war in US history where more military personnel were killed by enemy soldiers than by disease and infection combined. The lessons learned from previous wars and from challenges encountered early on in WWII were applied to lifesaving health practices by the end of the conflict.

The breakthroughs in the field of military medicine resulted in saving the lives of thousands of US soldiers. The shift in deaths from battle injuries (BI) vs. those from disease and non-battle related injuries (DNBI) can be seen clearly from the Civil War to WWII (See Chart 1.1). During the Civil War there were over 80,000 more DNBI deaths than BI deaths among the Union army alone. By WWI the two were almost even, with only about 5,000 more DNBI deaths than BI deaths. WWII was the pinnacle in the evolution of military medicine as there were nearly 150,000 more BI deaths than DNBI deaths (Kelley 23). It is easy to credit this change to the introduction of Penicillin into the arsenal of military medicine, but in reality Penicillin was only a part of a wholly reconfigured plan of attack. The general pattern in Chart 1.1 is a hopeful indication of the role of medicine in modern warfare.

[Chart 1.1]

US ARMY DEATHS FROM DISEASE AND NONBATTLE INJURY VS BATTLE INJURY, MEXICAN WAR THROUGH PERSIAN GULF WAR.

War	Number Serving	Disease and Non-battle Injuries		
		Battle Injuries (BI)	(DNBI)	DNBI:BI
Mexican War	78,718	1,733	11,550	6.7
Civil War (Union)	2,128,948	138,154	221,374	1.6
Spanish American War	280,564	369	2,061	5.6
World War I	4,057,101	50,510	55,868	1.1
World War II	11,260,000	234,874	83,400	0.35
Korean War	2,834,000	27,709	2,452	0.09
Vietnam War	4,368,000	30,922	7,273	0.24
Persian Gulf War	246,682	98	105	1.1

One positive side effect of war is that it drives rapid increases in industry and innovation. WWII is quite possibly the best example of this, because it not only brought America out of The Great Depression, it forced innovative medical solutions, such as the introduction and mass production of Penicillin by D-day and the rapid testing and approval of DDT for use in jungle warfare. The ability of the US military to acquire and implement new drugs and preventive measures, before the private sector is able to, allows the health community to understand the effects of such procedures before they are incorporated into broad civilian use. The lessons learned from the wartime use of new and experimental treatments led to faster implementation of

positive public health policies in civilian life. The end of WWII brought health concerns from the front lines to the home front and encouraged radical changes in a faltering system.

The first official battle in the Pacific for the US was December 7th 1941, when Japan attacked Pearl Harbor, however the US presence in the Philippines dates back to before the Philippine-American War in approximately 1898. From 1941 to 1942, Japan managed to push allied forces out of the Philippines and as far south as New Guinea. Conditions on these tropical Pacific islands were atrocious, and with no chance of any formidable US reinforcements, Japan quickly gained momentum in the area. In the spring of 1942 as Allied troops were being pushed off Bataan, conditions were harsh for soldiers. “Rations on Bataan were down to 1000 calories a day, ‘barely sufficient to sustain life without physical activity’. Nearly 80 percent of the front line troops were suffering from malaria, 75 per cent had dysentery and 35 per cent had beriberi. The front totally collapsed” (Wiest 72). These conditions had already beaten the US troops in the area before they finally surrendered to Japan. Major health problems left soldier morale too low to withstand the Japanese offensive of 1942, forcing allied troops out of the Philippines.

[Image 1.1] (History Place WWII in the Pacific)



Soldiers with their hands tied behind their backs on the Bataan Death March

One challenge with the great advances in military medicine during WWII is that everything was new, which meant that it had to be smoothly worked into existing medical practice. Prior to new drugs and treatments being accepted there is a transitory period in which their use is experimental and this puts a great strain on medical personnel. Captain William D. Jones Jr. of the United States Naval Reserve commented that “during the early years...

prevention and treatment were in continuous development and testing in combat, if available at all in numbers that would make a difference" (Jones 192). As the Allies were being pushed out of the South Pacific, the medical field was expanding at a rapid rate, but the most serious advances had yet to be applied on the grand scale that soldiers would see towards the end of the war. This delay in implementation of the most modern life saving practices was costly to the poorly supplied, over worked and exhausted troops who were unable to fight off illness and the Japanese simultaneously.

Marine William L. "Bill" Ogden gives a breakdown of what kinds of injuries and illnesses marines might have dealt with during the Pacific campaign. Ogden himself reports having "20 cavities in my teeth, malaria, dengue [fever], jungle rot, dysentery, hearing loss, concussion--but no wounds." This is quite a list of ailments for a Marine that had no wounds, and a good indicator of the types of problems encountered in the tropics. And yet Ogden is a prime example of the complexities that military medicine could expect to encounter in the field. Another account, from Marine Emil C. Buff, tells how he was returned to duty from a serious skin infection after only four days in the hospital. "[Medical personnel] were there to keep as many men at as many guns for as many days as possible and did a good job" (Jones 200). This is a very keen, and painful, observation illuminating the American fighting spirit that would accept nothing short of complete and utter surrender of her enemies. Medics, doctors, surgeons and nurses, needed to clear beds for new casualties and return men to the front as soon as humanly possible.

Evolution of US Military Medicine 1775-1945:

Military Medicine in America started with the formation of the Continental Army in preparation for the US Revolutionary War. The US Army was established in 1775 and later that year it was determined that military healthcare of some sort was necessary for any type of large scale operations. The Hospital Department was founded and responsible for twenty thousand troops with only “one Director General and Chief Physician, four Surgeons, one Apothecary, twenty Surgeon’s Mates, one Clerk, two Storekeepers, one Nurse for every ten sick, and laborers occasionally as needed” (Ashburn 14). The war began and it was clear that more medical personnel were needed. As the Continental Army grew it was determined that the Army needed approximately one physician for every 5,000 enlisted men. This marked the beginning of military medicine in America and is the root for medical services in WWII.

By the time of the Civil War, the military had grown considerably and so had the medical department. Despite this growth, military medicine remained extremely primitive and proved insufficient for the needs of the troops. The majority of deaths during the Civil War occurred from infections after the soldiers had already been taken to nearby field hospitals, because conditions were highly unsanitary and antibiotics were non-existent. By the end of the Civil War US military medicine doctrine had been established. The medical director of the Army of the Potomac, Jonathon Letterman, said that the key purpose of medical officers is to “strengthen the hands of the Commanding General by keeping his army in the most vigorous health, thus rendering it, in the highest degree, efficient for enduring fatigue and privation, and for fighting” (Letterman 100). The Civil War resulted in the most US deaths of any conflict to date. Poor

medical practices were responsible for the majority of these deaths, and have served as an important lesson to future generations of healthcare providers.

One man who had a significant impact on military medicine and public health between the Civil War and WWI was US Army Surgeon General George Miller Sternberg. Appointed in 1893, Sternberg was already an established Army physician and medical researcher with progressive ideas. Some of Sternberg's greatest accomplishments include founding the first graduate school of preventive medicine and public health in the US in 1893 and setting up overseas research facilities to study tropical diseases. These overseas research facilities were designed to give scientists the opportunity to work closely with local experts on health issues that posed a potential threat to US military personnel. The Philippines was host to one of these facilities and proved to be useful as America prepared for WWII (Kelley 107-108). Sternberg's emphasis on education and research gave military medicine an essential push in the direction of prevention rather than simply palliation.

The lessons from the Civil War and advances in medical knowledge gave military medicine an edge by WWI. One addition to treating wounds during WWI is debriding, or cutting off, dead or infected tissue around wounds to reduce systemic infections. Changes in medical understanding clearly demonstrated that after surgery or a serious wound, it is necessary to allow a period of rehabilitation prior to returning to normal duties. Other important contributions to military medicine that came about during WWI are antiseptic irrigation of wounds to prevent gangrene, and a new found appreciation of the damage that poor hygiene and sanitation can have on health at the front (Laughead *The Medical Front WWI*). Some of the unexpected problems experienced during WWI include endemic influenza with no preventive

measures in place and psychological conditions like shell shock. The lessons of WWI were taken to heart and revised methods were applied as real lifesaving measures during WWII.

The period between WWI and WWII was filled with decommissioning of military strength and economic hardships that forced major cuts in defense spending. This resulted in a downsized US military capable of maintaining homeland security, but not offering support abroad. The pre-WWII Navy was ill-equipped for full-scale US involvement in a two front war. In 1941, the Navy was able to function with a minimal amount of medical facilities, which consisted of "eighteen continental hospitals, three overseas hospitals, two mobile hospitals, and two hospital ships in commission." Employed by the Navy at this time were "13,500 physicians, dentists, nurses, Hospital Corps officers, and corpsmen [aka pharmacists' mates]." As this proved to be an insufficient number of both medical personnel and facilities, the Navy began a massive expansion program, which by 1945 included "169,000 personnel... assigned to fifty-six stateside hospitals, twelve fleet hospitals, sixteen base hospitals, fourteen convalescent hospitals, fifteen hospital ships, five special augmented hospitals, and many dispensaries" (Herman 35). The annual growth rate of medical personnel employed by the Navy during this time was 1,252%. This kind of expansive growth was seen in all branches of the military as civilians decided to answer the call of duty and respond to the enemy threat.

The medical advances of WWII were vast and led to effective changes in policy and procedures. An example of these changes include the sulfa drugs that were distributed to every soldier early on in the war with orders of spreading the sulfa powder liberally over fresh wounds in an effort to reduce infection. Sulfa drugs were no longer required as oral medication by the end of the war, because the drug Penicillin had been mass produced and was readily available.

Morphine was frequently used by medics and national blood plasma programs became prominent. Natural Quinine drugs for Malaria were the treatment of choice prior to the war, but the synthetic drug Atabrine soon took its place because it was at least equally effective, but much easier to mass produce. New medicines became catalysts for decreased mortality rates.

Great improvements were made with the broader understanding of the relationship between hygiene, sanitation and health. This knowledge led to more effective methods of improving hygiene and sanitation in a variety of wartime situations. One positive change in sanitation was the proper disposal of waste, to be sure that water sources did not become contaminated. Performing surgery under sterile conditions to prevent infections was a major change in hygiene practices. Hygiene and sanitation were addressed together as complementary issues which proved to be an effective technique.

Infectious Disease:

Infectious diseases were responsible for tremendous losses of manpower and work hours during WWII, but medicinal treatments helped to reduce the subsequent death toll. Had WWII been fought with the medical knowledge from 100 years earlier, disease and non-battle related injuries would have definitely exceeded the deaths from battle injuries and probably tripled the total number of US deaths. As it stands though, the tremendous strides in prophylactic medicine, hygiene and sanitation, and vector control allowed the US to manage venereal diseases (VD) like gonorrhea and syphilis, implement large scale immunization campaigns for Typhoid fever, smallpox and numerous other conditions and combat vector-borne diseases like yellow fever, dengue hemorrhagic fever and, most importantly, malaria.

During the final years of combat, American medical personnel were knowledgeable of the latest advances in medicine and skilled in their application to the point that US troops had much higher survival rates than Japanese troops under similar circumstances. Diseases like malaria were a major impediment to both US and Japanese forces. The US, however, was more successful in responding to tropical diseases by joining together major research and development groups like the National Research Council and the Office of Scientific Research and Development's committee on medical research to work towards curbing the devastating problem of diseases like malaria. One area where this clearly comes into focus is during the fighting on Bougainville where in several months early in 1944, the Japanese armed forces were reduced from 35,000 to 22,000. The US estimates of casualties during this period put Japanese combat deaths at about 3,000, but it is suspected that nearly "ten thousand others... had perished of

disease" (Cowdrey 181). US deaths by disease accounted for significantly lesser numbers of deaths as precautionary measures were strictly enforced.

[Image 2.1] (History Place World War Two in the Pacific)



Marines exhausted from combat were more susceptible to infectious disease (February 1944).

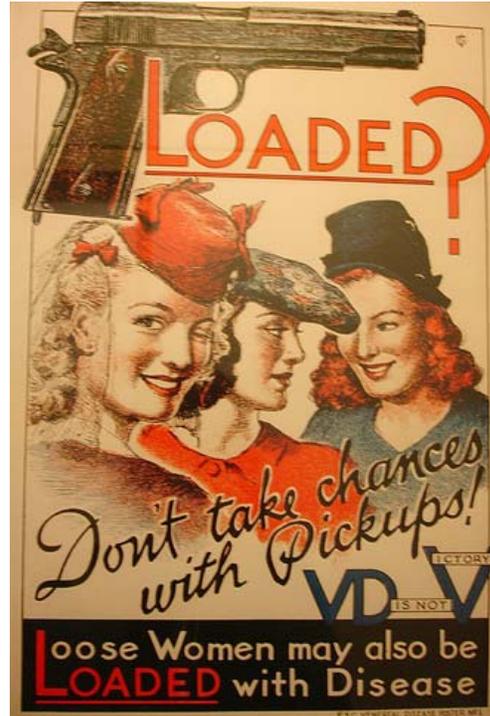
Venereal Disease:

Venereal diseases are any diseases that can be spread sexually from one partner to another and are now more commonly referred to as sexually transmitted diseases (STDs) or sexually transmitted infections (STIs). At the start of WWI, venereal disease was a major cause of incapacitation or rejection from active duty. This problem inspired action including educational programs, chemical prophylaxis, and military promotion of condom usage. The venereal diseases that were most prevalent during WWII include syphilis and gonorrhea. VD inspired the creation of rapid treatment centers and research laboratories in association with the United States Public Health Service (Cutler 372-374). The US started a poster campaign to reduce the incidence of VD among current and potential servicemen during the war. Image 2.2 summarizes the anti-VD campaign focused on encouraging soldiers not to engage in sexual activity with “pick-ups”, “Good Time Girls,” or “Prostitutes.” Image 2.3 displays several attractive, flirtatious women next to a cocked pistol with the word “Loaded?” in between them to indicate that they are likely to be “loaded with disease.” It was believed that the most effective form of protection for military men was convincing them not to have multiple sexual partners. Another way to discourage the spread of VD was to threaten WWII soldiers with extended stays overseas if they were found to be positive for syphilis or gonorrhea as can be seen in image 2.4.

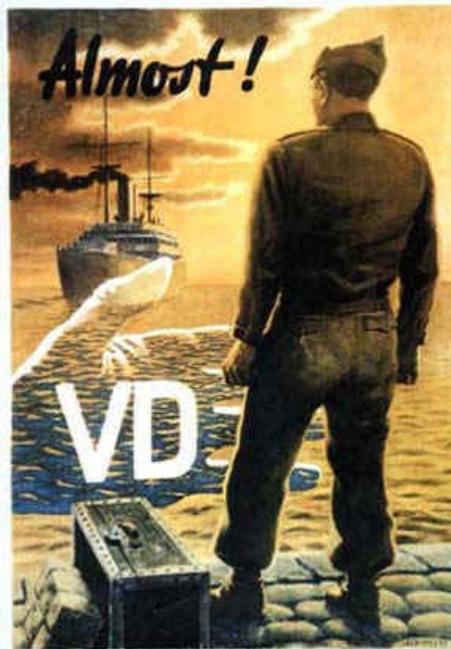
[Image 2.2] (Zazzle WWII propaganda posters)



[Image 2.3] (Zazzle)



[Image 2.4] (SGM Herb Friedman Venereal Disease Propaganda)



Immunization Campaigns:

Immunization campaigns among military personnel in all branches of service were a key form of prophylaxis in WWII. The art of developing effective immunizations and delivering them to large groups of people was still being perfected in the 1940's. As a result of the infancy of the US vaccination program, immunization records could vary greatly for a soldier in 1942 vs. 1945. The available vaccines during the war include smallpox, typhoid, cholera, yellow fever, tetanus, typhus, influenza and Japanese B encephalitis. The effectiveness of these vaccines is debatable, but they had all proved efficacious in clinical trials. An account from the memoir of Fred Addison, a Marine in the 1st Armored Amphibian Battalion, recalled a period during the war where he had "received seven inoculations in the past couple of days... Platoons were scheduled to be at sick bay at a certain time. We'd line up in a single file and a 'pecker checker' on either side of you would plunge the needles into your arm" (Jones 192). With such a large and steadily growing list of vaccines, anyone who held particular disdain for needles would be forced to get over it.

[Image 2.5] (Rootsweb Ancestry.com)

IMMUNIZATION REGISTER ¹

LAST NAME		FIRST NAME		ARMY SERIAL NO.	
Mikacevich		George P.		17110629	
GRADE	COMPANY	REGT. OR STAFF CORPS	AGE	RACE	
Pvt	48899	Air Corps		W	

SMALLPOX VACCINE

DATE	TYPE OF REACTION ²	MED. OFFICER ³
10/10/42 4/12/44	None i.d.	J.M.P. J.M.P.

TRIPLE TYPHOID VACCINE

DATES OF ADMINISTRATION				MED. OFFICER ³
SERIES	1ST DOSE	2D DOSE	3D DOSE	
1st.	10/10/42	OCT 19 '42	OCT 28 '42	J.M.P.
2d.		STIM 11/10/42		J.P.R.
3d.	18 DEC 1944			

TETANUS TOXOID

INITIAL VACCINATION			STIMULATING DOSES		
DATE	MED. OFF. ³		DATE	MED. OFF. ³	
1st dose: 10/10/42	J.M.P.		11/10/42	J.P.R.	
2d dose: OCT 28 '42	J.M.P.				
3d dose: 11/10/42	J.M.P.				

YELLOW FEVER VACCINE

DATE	LOT NO.	AMOUNT	MED. OFF. ³
8/5/44	AB336	1/2 CC	

OTHER VACCINES

DISEASE	DATE	TYPE OF VACCINE	DOSES	MED. OFF. ³
TYPHUS	8/12/44	COMP.		
CHOLERA	8/12/44	COMP.		
Blood type O				

J. W. [Signature] M. C.,
 U. S. Army.
 16-20902

Immunization Register for Pvt. George P. Mikacevich Army Air Corps

Arthropod Related Illness:

It is estimated that during WWII as many as 24,000,000 man-days were lost to arthropod related disease and injury (Peterson 147-161). This number includes illness from yellow fever, dengue hemorrhagic fever and malaria. A key difference in malaria vs. dengue and yellow fevers is the method of vectoral transmission. All three are transmitted to humans by infected mosquitoes, but only specific types of mosquitoes actually carry these different diseases. Malaria is a parasitic plasmodium passed on to humans by the infected female anopheles mosquito, while both yellow fever and dengue hemorrhagic fever are flaviviruses spread via the *Aedes aegypti* vector for transmission to humans. Yellow fever is the only of these three tropical diseases that had a vaccine available during WWII and even today, effective and affordable vaccines are not available for malaria or dengue hemorrhagic fever. The symptoms of yellow fever range from nausea, fever, muscle aches and fatigue to confusion, seizures and coma. Dengue hemorrhagic fever often starts with severe headache, fever and hemorrhagic manifestations which can lead to severe hemorrhage and death (CDC Mosquito-Borne Diseases).

[Image 2.6] A female *Aedes aegypti* mosquito



[Image 2.7] Female Anopheles mosquito



Marine William L. "Bill" Ogden recalls his bout with dengue hemorrhagic fever during the war bringing to light a serious issue plaguing crowded barracks. Diseases spread by arthropod vectors, like mosquitoes, would spread more rapidly as the numbers of infected soldiers increased. This is because the number of disease carrying mosquitoes coincides directly with the number of infected humans in an area. One of the most serious of Bill's reported health failures was Dengue fever. He reports that "when I got dengue the whole division came down with it," and Bill's case was so severe that he was "unconscious for close to 10 days," which is significantly more serious than the average fever (Jones 196). Yet dengue fever was not uncommon for a US marine stationed in the WWII Pacific Theater of Operations.

Malaria:

Tropical infectious diseases were a primary factor in lost work hours. The worst of these was malaria, which caused high fever, fatigue, nausea, vomiting and general malaise in average cases, but could quickly lead to a more severe and debilitating state including premature death (CDC Malaria). The sheer number of malarial infections during WWII was mind boggling, with an annual average during its peak of more than 115,000 cases of malaria among US troops alone (Stone 27-29). Malaria is a serious disease that continued to be a threat after WWII and still requires a great effort for control. Brigadier General William Tigertt reflected after the war that "malaria can never be regarded with complacency and always must remain high on the military medical research priorities list" (Tigertt 82). Malaria and the mosquitoes that transmit the disease proved to be a formidable enemy in the Pacific Theater of Operations and as such, required significant efforts to win the fight.

Malaria is only transmitted by the infected female anopheles mosquito. The female anopheles mosquito becomes infected by feeding on a human that is currently infected with Malaria and thus, there are ways to prevent transmission. It generally takes between 9-21 days from the time the anopheles mosquito takes its malaria infected blood meal before it can transmit the active virus to another human host. Malaria is only endemic in tropical climates because anopheles mosquito larvae grow in standing water and the protozoan parasite that is passed from the mosquitoes to humans will die at temperatures below 60 degrees Fahrenheit. Warmer temperatures increase the risk of transmission by shortening the time required for the parasitic malarial plasmodium to become active within the mosquito between bites. There are four types of protozoan parasites, but the two that are of the greatest concern to humans are *plasmodium falciparum* (most common in sub-Saharan Africa) and *plasmodium vivax* (common in the South Pacific). After the initial infection, *plasmodium vivax* will sometimes lie dormant in the liver for months or even years before becoming active again (CDC, Malaria). This explains the frequent incidence of malarial relapse during WWII, even after troops have left the malarial zones.

[Image 2.8] (About.com. Malaria).



"Prevent Malaria, Shorten the War" (1941-1945).

Mosquitoes were at their peak during the hot humid summers filled with monsoons and standing water. In order to combat Malaria, it was necessary to administer medicinal prophylaxis, and go to the source attacking the mosquitoes themselves. *The War Department Field Manual* on military sanitation from July 1945 offers a detailed description of how to keep military personnel in optimal fighting condition through “control of communicable diseases, troop housing, waste disposal, water purification, mess sanitation, insect control and personal hygiene” (Wallace 2). This field manual features a large section on malarial control, including control of individuals, groups and malarial breeding sites (Chart 2.1). There are also specific details on how to accomplish these tasks ranging from the exact formula to make larvicide oil mixtures to be spread over stagnant water sources and how to repair torn mosquito screens. This manual holds the answers that military officers would have needed to adequately protect their troops during combat in the Pacific.

Anti-malarial methods during WWII:

Control of Breeding sites:

- The ideal location for a camp is on high dry ground, at least a mile away from important breeding places of mosquitoes and from native villages, where the infection rate is usually high. Infected natives should not be allowed within a mile of the camp after dark.
- Weekly oiling of water sources like ponds, swamps, slow-moving streams, drains, water receptacles, tree holes, and roof gutters with diesel oil, fuel oil or a combination of motor oil diluted with kerosene. Paris green larvicide may also be used and DDT should be used either in the oils or in dusting, to make treatment more effective.
- Constructing good ditches and drainage systems around camps and areas of water accumulation to drain standing water into one area that can be more easily treated.

Control of individuals:

- clothing choices should not leave areas of the body exposed to mosquitoes especially at night and in the jungle. Pants and long sleeve shirts as well as boots and gloves should be worn at night.
- Mosquito nets should cover men's faces and necks except in extreme combat situations and bed nets should be used every night in malarial areas. There are places in the Tropics where 20% of the troops have caught malaria because of a single night's exposure without nets.
- Insect repellents should be applied often to clothes and skin

Control for Groups:

- Spray killing with hand sprayers
 - Aerosol killing with mosquito bombs
 - DDT residual spray
 - Mosquito-proofing all buildings where men gather with mesh screening, double screen doors, automatically closing doors and immediate repairs to any holes.
-

Along with all the protective measures outlined in Chart 2.1, several prophylactic drugs were required during the war for each soldier stationed in an endemic malarial zone. Natural quinine was the prewar drug of choice for fighting malaria, but natural sources of quinine were unavailable by the time America joined in the fighting which led to the development of synthetic alternatives. US involvement in this effort included the testing of over 14,000 anti-malarial compounds, 80 of which made it to the human testing phase. The synthetic drug that was used in place of natural quinine was quinacrine hydrochloride (Atabrine) which was originally discovered in Germany during the 1930s. Atabrine is a bitter yellow pill with numerous side effects including headaches, nausea, and vomiting, and occasionally even temporary psychosis (Steinert WWII combat medics). As a result of the undesirable side effects attributed to Atabrine, it was difficult for officers to ensure that their men were actually taking the pills without strict supervision. After WWII, chloroquine, a more effective drug with fewer side effects was introduced and replaced Atabrine in military use.

[Image 2.9] (Flickr Atabrine).



Sign posted outside of a military hospital to show the gravity of non-compliance.

The US anti-disease effort was increasingly more effective as the war with Japan raged on. The positive effects of US research and development reached beyond US troops to be felt throughout the allied battalions in the Pacific. Japan failed to focus the necessary attention on disease prevention, likely as a result of increased pressure from Allied advances. This resulted in a greater loss of Japanese troops to tropical diseases each year. This is starkly in contrast to allied casualties due to tropical diseases, which were far worse in the early years of the conflict. One example of allied success fighting malaria can be seen in the decline of malarial infection experienced by the Indian Armed Forces. They saw rates of malaria drop from over 50% in 1942

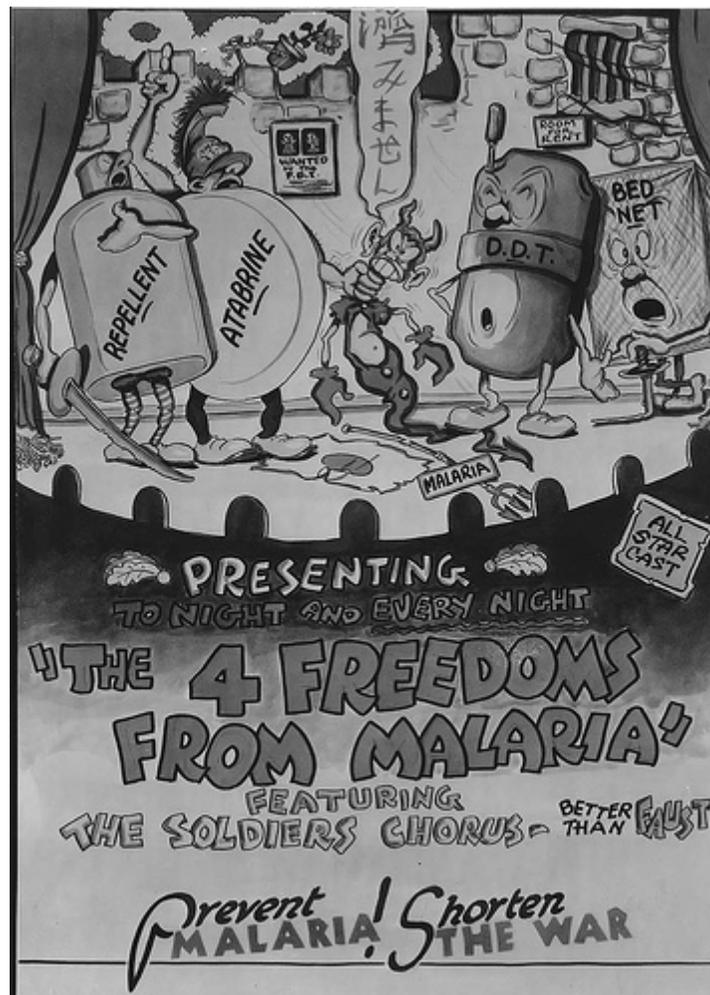
to about 15% by 1945 (Raina 7). Similar trends were observed by all allied forces that sought to adhere to US malarial control policy. The advances in fighting not only the malaria virus in humans, but going directly after the source by eliminating the mosquitoes responsible for transmitting the disease had an incredible impact in the fight against malaria.

One of the most effective tools in protecting troops from malaria in WWII was the extremely powerful insecticide dichlorodiphenyltrichloroethane (DDT). DDT was first discovered as an insecticide in 1939, but serious testing was not performed until 1942-1943 (Russel 5-13). It was not until the final years of the war that DDT was widely used to reduce malarial threats in the Pacific theater of operations. DDT has a strong residual effect, meaning it will still be fatal to insects weeks and even months after it is sprayed. DDT only requires brief contact with insects to prove fatal and also has excitorepellent effects, meaning it will deter mosquitoes from even entering an area where DDT is present (Wallace 118-128). DDT takes a long time to break down and is fat-soluble, so there is fear that DDT will build up to toxic levels and do serious damage to top predators, including humans. DDT was considered a miracle insecticide in the 1940s and proved valuable in the Pacific.

Infectious diseases wreaked havoc in the Pacific Theater of Operations, but the ever changing US medical program worked around the clock to save the lives of US military personnel. The devastation from disease includes loss of manpower, increased burden on the military health support system, and decreased unit morale. All of these factors reduce the commander's ability to accomplish the mission at hand (Kelley 477). In order to keep units healthy enough to fight, it was necessary for expansive programs in prophylactic medicine, hygiene, sanitation, and vector control. Without these programs in place, the US would have

been unable to successfully manage the challenges of venereal diseases (VD), implementing large scale immunization campaigns and combating vector-borne diseases.

[Image 2.10] (Flickr, Malaria)



Four prominent methods of preventing malaria during WWII.

Infection:

Infections are most likely to occur when the body is weakest and open wounds are left exposed or unsanitized. Conflict situations breed infections. Soldiers are facing extreme stresses that in and of themselves will weaken the immune system and have a multiplicative effect when combined with other problems. The skin and mucous membranes of the body are its way of physically protecting the vulnerable internal areas from a trillion microbes and microorganisms that cause damage once inside. Even minor cuts and scrapes from daily noncombat activities like scrambling over sharp rocks and hiking through dense jungles can lead to life-threatening infections if not treated properly. The more serious the injury, the more likely it is to become infected. Marines with shrapnel in their chest or a bullet through the abdomen needed immediate attention to stop the bleeding, manage the pain, and immediately sanitize the wound and prevent infections. The urgent danger from fresh wounds is the possibility of developing local infections. If allowed to fester, these types of infections can easily spread and often prove fatal once they have become systemic.

It only takes a second for the required bacteria to enter a wound, but it generally takes several hours or days for any signs of infection to set in. This is why it was critical that every wounded soldier in WWII received preventive care to minimize the chances of infection. WWI is when preventive medicine gained prominence as an effective method of saving lives and reducing the amount of time a soldier was out of commission after being wounded (Grabenstein Epidemiologic Reviews). The biggest problem with preventive medicine in WWI is that antibiotics of any kind had yet to be discovered and thus treatment was limited. The interim

period of the 1920s and 1930s proved to be a time of numerous discoveries and medical innovations. The most important breakthroughs during this period include the Sulfa drugs and Penicillin. These drugs are responsible for saving the lives of hundreds of thousands of US soldiers during WWII and untold millions worldwide.

Sulfa Drugs during World War II

Initial testing of antimicrobial Sulfa drugs in rats proved effective in curing certain kinds of infections in 1932, and inspired later human testing. By 1935 the Sulfa drug Prontosil was patented and used sparingly to test efficacy in different cases of human infection (Lesch 3). Sulfa drugs come in several forms including Sulfanilamide, Sulfapyridine and Sulfathiazole and are most often either given orally or physically sprinkled on open wounds. By the start of WWII, the Sulfa drugs were being used broadly with the hope of it being a ‘silver bullet’ for infection. In 1939, *Time* magazine referred to Sulfanilamide as the original “wonder drug,” because of the range of conditions it could treat (*Time* 1939). This hopeful outlook played a role in the slowed development and advancement of Penicillin in the early years of WWII. The pharmaceutical community placed their hopes in these drugs and it was not until the limitations of the Sulfa drugs were realized that large-scale efforts began towards mass-production of Penicillin.

[Image 3.1] (Steinert WWII combat medics)



First aid kit with sulfanilamide powder and bandage

Sulfa drugs were the prophylactic drug of choice until 1944 when Penicillin became available in large quantities. Penicillin quickly proved to be the most effective medicinal means of preventing and controlling infections. All military hospitals and mobile clinics at the time gave the wounded frequent doses of sulfa based medications to control infections. Sulfa drugs are bacteriostatic, meaning they can inhibit growth or reproduction of bacteria, but lack the ability to actually kill them (MedicineNet bacteriostatic). As a result of this inability to kill bacteria, sulfa drugs were most effective if used immediately to prevent any bacteria in a wound from multiplying and doing any kind of large scale damage. In order to maximize effectiveness, sulfa powder was a major part of the WWII medic's arsenal. Medics had a larger supply, but to be sure that every soldier was treated as soon as possible, every soldier was issued a first aid pouch that contained a packet of Sulfanilamide powder and a bandage to dress the wound (Image 3.1). Soldiers were instructed to evenly distribute the contents of the packet over wounds immediately and attempt to bandage them on the spot before seeking additional medical attention in order to limit exposure to microbial enemies.

Penicillin the Wonder Drug

[Image 3.2] (Mailer 44)



Penicillin was first used in North America to successfully treat a case of streptococcal septicemia in March 1942 (Grossman 135). The importance of this new treatment was mostly overlooked at the time, but soon spurred a pharmaceutical revolution in America. Penicillin is the first mass produced antibiotic. This means that unlike bacteriostatic drugs, including the sulfa family, Penicillin will kill bacteria that cause infections. Prior to the 1930s, if someone became ill with a serious bacterial infection, the only real hope they had was to produce a strong immunological response in order to naturally wipe out the root of the problem. By 1935 sulfa drugs were on the market, but serious limitations were encountered. It was discovered that sulfa drugs were ineffective at killing bacteria, especially staphylococci and pneumococci bacteria, and could only prevent further spread. The problem with merely containing an infection is that it will not save the lives of patients that start treatment once they are already very sick. Many people do not receive medicine before a bacterial infection sets in and in the case of staph infections or pneumonia, sulfa treatment is not very effective (Mailer 44). By the mid 1940s, Penicillin had mostly replaced Sulfa drugs as the primary medicine for fighting infections.

Penicillin's antibacterial properties were discovered by accident in the basement of St. Mary's Hospital in London in 1928, by bacteriologist Dr. Alexander Fleming. Fleming was studying staphylococci in sealed petri dishes, but had forgotten to replace the lid on one of his samples after examining it under a microscope. Airborne *Penicillium* spores managed to land in the open culture plate and rapidly multiplied. This might have been discounted as nothing more than experimental contamination by a common mold and thrown away. Yet Fleming noticed that the area where the mold grew had a ring around it that was completely free of the staphylococci bacteria similar to that seen in Image 3.3. This inspired Fleming to study the effects of this new bacterial killer, but he did not believe it would have any widespread medical use (Mailer 41). It was nearly a decade later when Fleming's work was continued by a group of Oxford scientists that included the clinical trials needed to gain support for development of the Penicillin.

[Image 3.3] (Case Access Excellence)

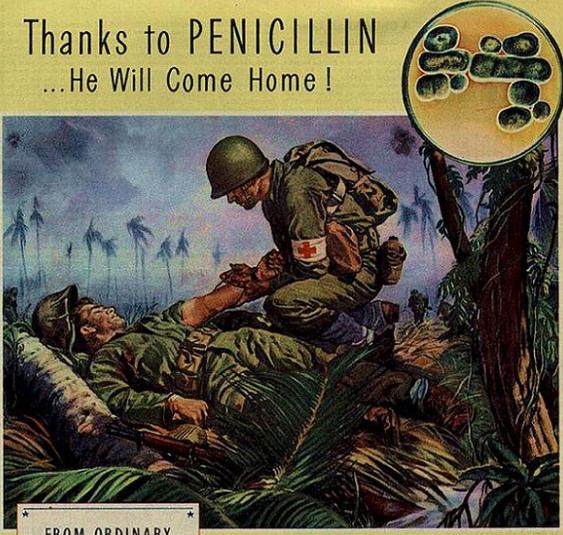


Note that growth of the bacteria *Staphylococcus aureus* is inhibited in the area surrounding the invading penicillin-secreting *Penicillium* mold colony.

By the time Penicillin had gained the necessary experimental backing to be developed into a new drug for clinical use by humans, Europe was engulfed by war. Thus America was forced to take on the responsibility of developing and refining a way to mass produce Penicillin using an effective and easily sustainable method. Penicillin was originally made from actual descendents of Fleming's first mold findings that had been kept alive in various laboratories. The effectiveness of this variety was unpredictable and the pharmaceutical companies were unable to produce the vast quantities and pure quality required. In a nationwide search for a superior mold, an overripe cantaloupe in Peoria, Illinois, covered with *Penicillium chrysogenum* proved to hold the key (Mailer 42). Major investments were made and Penicillin began to be produced at astronomical rates. The first patient in America given Penicillin in 1942 used half of the current supply in her treatment. By June 1944, 300 billion units of Penicillin, enough to treat nearly 150,000 patients, were available for military use. During 1944, 1.6 trillion units of Penicillin were produced and nearly 8 trillion units were produced during 1945 (Mailer 43). One factor that positively contributed to this massive production rate was a free exchange of development plans between pharmaceutical companies that would normally be kept in strict confidence for a number of years. This corporate collaboration and free exchange of ideas occurred, because of the desperate situation of soldiers during WWII. Privacy restrictions today would not allow such a free exchange of new ideas in pharmaceuticals. The free flow of Penicillin demonstrates the special efforts of a nation unified by the threat of war.

[Image 3.4] (Steinert WWII combat medics)

Thanks to **PENICILLIN**
...He Will Come Home!



FROM ORDINARY MOLD—
the Greatest Healing Agent of this War!

On the gray, green-and-yellow mold above, called *Penicillium notatum* in the laboratory, grows the miraculous substance first discovered by Professor Alexander Fleming in 1928. Named penicillin by its discoverer, it is the most potent weapon ever developed against many of the deadliest infections known to man. Because much of mold was already a part of Schenley enterprises, Schenley Laboratories were well able to meet the problem of large-scale production of penicillin, when the great need for it arose.

When the thankless battle of this war has subsided to pages of silent print in a history book, the greatest news event of World War II may well be the discovery and development—not of some vicious secret weapon that *destroys*—but of a weapon that *saves* lives. That weapon, of course, is penicillin.

Every day, penicillin is performing some unbelievable act of healing on some far battlefield. Thousands of men will return home who otherwise would not have had a chance. Better still, more and more of this precious drug is now available for civilian use—to save the lives of patients of every age.

A year ago, production of penicillin was difficult, costly. Today, due to specially devised methods of mass-production, in use by Schenley Laboratories, Inc. and the 20 other firms designated by the government to make penicillin, it is available in ever-increasing quantity, at progressively lower cost.

Listed in "THE DOCTOR FIGHTS" under NATIONAL MARKET. See your doctor for name and address. U.S. Pat. 2,463,566.

SCHENLEY LABORATORIES, INC.
Lansing, Michigan
Producers of **PENICILLIN-Schenley**



Penicillin proved to be the most effective means of fighting infections

The US decision not to join WWII when Britain and France declared war against Germany saved thousands of American lives because medicine was advancing every year. Penicillin was not a significant factor in military medicine until 1944; any usage before this time was generally experimental in nature, and rarely seen in numbers that could make a significant impact on the health of troops on the front lines (Jones 192). Sulfa drugs were the primary medical weapon of choice against bacterial infections and the introduction of Penicillin in combat situations was initially only used to fight cases of sulfonamide-resistant infections (Lesch 211). The delayed production and implementation of Penicillin from the time it was first discovered in 1928 until it was seriously considered for clinical usage around 1940 may be responsible for a considerable number of deaths. The death toll would have been far more catastrophic if Penicillin had never gained the necessary scientific backing early on. Yet Penicillin would never have made it to the front lines if it had not been for the first companies that agreed to dedicate significant resources towards the rapid development and production of the new wonder drug. It was only through collaborative efforts between the scientific and financial communities that brought about the tool that made the difference for Allied casualties.

Other Factor in WWII Medicine:

The Use of Plasma during World War II

Blood transfusions are crucial for saving the lives of seriously injured soldiers that are at high risk for bleeding to death. A program that can efficiently collect, transport and distribute blood on a large scale during a time of war can have a dramatic impact on lowering the mortality rate. Such a program was designed for the Allies in 1940. This program was known as the “Blood for Britain” project. But it was not whole blood that was used. Dr. Charles Drew of Columbia University realized that blood plasma was nearly as effective as transfusions of whole blood. Plasma has a much longer shelf life and numerous other benefits too. As it became evident that America would soon be pulled into the war, Dr. Drew was asked to lead a program similar to that of “Blood for Britain,” for the US war effort. This was the start of the American Red Cross Blood Donor Service. By the start of the US program, Dr. Drew had found a way to use dried blood plasma which lasted much longer and was light enough to be carried by field medics in forward positions (American Red Cross *Dr. Charles Drew*). The contributions of Dr. Charles Drew in discovering, designing, leading and organizing these two transfusion programs is credited with thousands of lives being saved.

[Image 4.1]



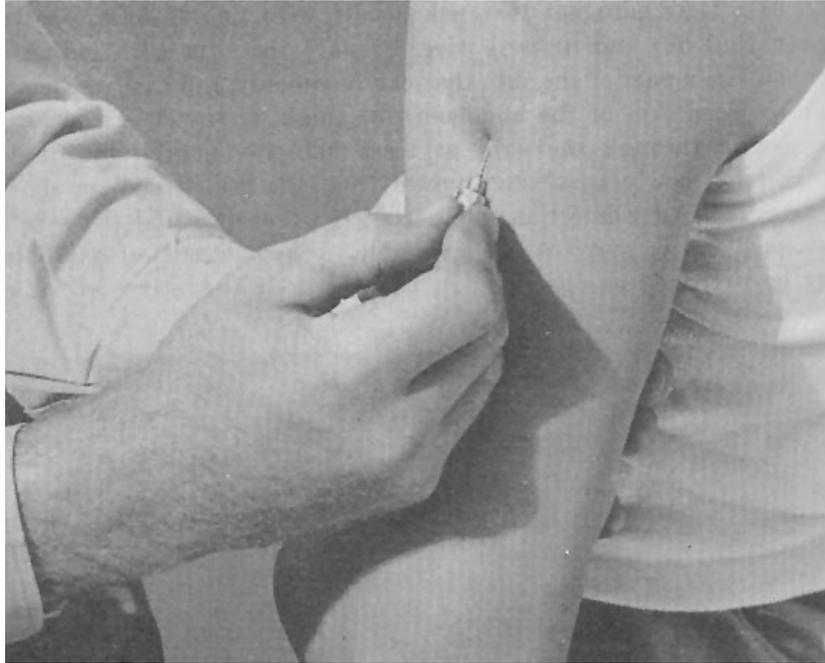
[Image 4.2] (Kendrick blood program)



Morphine to Kill the Pain

The most potent of all opium based drugs, morphine, is a strong central nervous system depressor having the dual effect of dulling pain and slowing respiration. Since morphine slows respirations, it was imperative that the WWII aid man be particularly careful to follow precautions for the proper administration to troops. Morphine was first isolated by German pharmacist Friedrich W. A. Sertürner, and initially used in the American Civil War, where high addiction rates were reported from overuse. During WWI, morphine was administered via reusable glass syringes, which proved inconvenient in combat situations. E.R. Squibbs and Sons, patented a disposable, one time use syrette in 1939, which was used by US forces during WWII. The disposable syrette proved to be ideal under high stress combat situations, and allowed medical personnel to quickly administer morphine as soon as possible to offer the fastest relief for wounded soldiers. Overdosing was easy, as one dose was extremely potent and simply required 20-30 minutes for the full effects to be felt. If within the first 30 minutes, multiple doses are administered, victims are likely to suffer from complete shutdown of the central nervous system, which includes respiration (Med Department Morphine Tartrate). Morphine was a quick fix meant only to be used in extremely severe injuries. Morphine provided potent relief from the horror of brutal casualties, but did little, other than reduce the likelihood of shock, to actually aid in the recovery process.

[Image 4.3]



Period photograph demonstrating the method of administration of Morphine Tartrate into the patient.

[Image 4.4] (Med Department Morphine Tartrate).



Illustration showing the combined Morphine Syrette and Iodine Applicator box.

Conclusion:

Medics in the field were forced to withstand extreme combat stresses with limited resources. Medic Robert Franklin gave a brief synopsis of life after basic training by saying “for the next two years I poured Sulfa powder and bandaged wounds” (Franklin 4). It was standard practice for the medic to immediately apply sulfanilamide powder to wounds and then thoroughly cover them in bandages to reduce the chances of infection. Morphine was only used in the most severe cases when it might be hours before a soldier could expect more significant medical attention and plasma was not administered until bleeding was under control. Yet being a medic in WWII was not simply about administering first aid. The medic played an important psychological role as well. It was necessary for medics to create distance between the emotions of treating severely wounded soldiers and having young men die in their arms. WWII combat medic Albert Gentile said "It isn't the acts of the aid man that becomes important, but rather the inner pain that he carries within himself” (Steinert WWII combat medics). Soldiers take comfort in knowing that there are people on the front lines with the sole purpose of rapidly treating their injuries. Thus the composure of the medics is directly correlated with the morale of the troops.

In forward field hospitals, that were constantly shuffling new casualties in and out, it was imperative to act quickly. This often required major surgery not far from the front lines. Larger rear hospitals were established in more stable areas to give soldiers the opportunity to fully recover. In order to save lives though, it was imperative to have flexible medical facilities that could move with the troops in order to minimize transport time from the area where the wound was inflicted to a safe location for medical treatment. An example of this can be seen in the operating room in Image 5.1 that was quickly assembled close to the front lines on the Solomon

Islands to performing major operations with little delay. With these roving medical facilities, it was crucial that proper hygiene and sanitation measures were taken to ensure that patients did not become more severely ill from their stay. The 18th US Army Surgeon General, George Miller Sternberg, made major strides against the spread of bacteria and disease. In his book, *Sanitary Lessons from the War*, written at the beginning of the 20th Century, Sternberg stated, “in the sick-room we have disease germs at an advantage, for we know where to find them, as well as how to kill them. Having this knowledge, not to apply it would be criminal negligence” (Sternberg 6). Sternberg’s work inspired modern American approaches to sanitary surgery and hospital procedures in the military.

[Image 5.1] (History Place, World War Two in the Pacific)



In an underground surgery room behind the front lines on Bougainville in the Solomon Islands, an American Army doctor operates on a wounded U.S. soldier. December 13, 1943.

The conditions in the forward field hospital were often unfavorable as a single battle could lead to a massive influx of seriously wounded soldiers. Captain Earl J. Wilson recalls the aftermath of the Battle of Tarawa and the limited space and medical capabilities at first. “The wounded who were able to stay on their feet put up palm fronds to keep the molten sun from the eyes of men who were more severely wounded than themselves. Some with one arm in a sling would use their good hand to wave flies away from the tired gray faces of the men on the stretchers” (Smith 552). All resources available were used to save wounded soldiers and the men looked after one another as well as they could when the medical personnel were unavailable.

Once soldiers had been stabilized at the forward field hospitals, they were sent back to better equipped facilities for advanced treatment and a chance to recover. Lieutenant William S. Gevurtz, Medical Corps, USNR, was the leading medical authority on such a transport from Bougainville to Guadalcanal. The following story illustrates the role doctors played in dealing with the psychological as well as physical needs of their patients.

The boy closed his good eye tightly. His lips trembled. He seemed ready to cry. The doctor grabbed his shoulders fiercely. ‘Now listen, dammit! Don’t you know you’ve got the best doctors in the world looking after you? Do you think when you get back to the Canal you’ll have some punk from Podunk taking care of you? You’ll have the best damn eye specialist in America working on you. And I just gave him a head start. Now cut it out or I’ll drop you over the side (Smith 456).

Military medical personnel of every rank, serving at home and abroad, had to adapt to the unique strains imposed by the war. It was often necessary that they relearn how to do their jobs, because of the unique health threats of foreign combat. The appropriate response to war was made and American mobilization of troops also brought a vast mobilization of health care personnel and facilities. In order to meet the needs of armed forces abroad, US citizens joined

together in an unprecedented full-scale war effort. The government worked hand in hand with the private sector and it seemed that everyone had a part to play in winning the war. WWII had a clear enemy US citizens strongly opposed. WWII is the last time that the United States has had nearly full support on the home front. Wars fought with massive domestic support are generally more successful than those in which the government decides to go to war without public support. WWII health care demonstrates the great strides that can be made when a country works together for a common goal.

The stresses of World War II were immense and forced massive expansions in the field of military medicine, which directly impacted the civilian medical field after the war's conclusion in 1945. Breakthroughs in fighting infection and infectious disease were expansive across the board and led to extremely positive wartime health outcomes compared to all previous American conflicts. The development of tools to fight malaria, like Atabrine and DDT, along with the infection fighting capabilities of sulfa drugs and Penicillin proved to be extremely useful in allowing soldiers to focus on combat rather than diseases or other non-combat related problems. Along with these new compounds, came a massive increases in immunization campaigns, and massive reforms in hygiene and sanitation. World War II was the catalyst for a stronger system of military medicine that reduced the mortality rate of troops on and off the field. WWII pushed the innovative and productive capabilities of America further than they had ever gone before. In the end, it was the bravery of medical personnel, equipped with the most advanced technologies in the world, that made the difference for soldiers on the ground. The Pacific Theater of Operations was a proving ground for the strength of American medical capabilities.

Appendix 1:

Timeline of Events in the Pacific

1941-1945

(History Place US Troops in Action 1942-1945).



1941

December 7, 1941 - Japanese bomb Pearl Harbor, Hawaii; also attack the Philippines, Wake Island, Guam, Malaya, Thailand, Shanghai and Midway.

December 8, 1941 - U.S. and Britain declare war on Japan. Japanese land near Singapore and enter Thailand.

December 9, 1941 - China declares war on Japan.

December 10, 1941 - Japanese invade the Philippines and also seize Guam.

December 11, 1941 - Japanese invade Burma.

December 15, 1941 - First Japanese merchant ship sunk by a U.S. submarine.

December 16, 1941 - Japanese invade British Borneo.

December 18, 1941 - Japanese invade Hong Kong.

December 22, 1941 - Japanese invade Luzon in the Philippines.

December 23, 1941 - General Douglas MacArthur begins a withdrawal from Manila to Bataan; Japanese take Wake Island.

December 25, 1941 - British surrender at Hong Kong.

December 26, 1941 - Manila declared an open city.

December 27, 1941 - Japanese bomb Manila.

1942

January 2, 1942 - Manila and U.S. Naval base at Cavite captured by the Japanese.

January 7, 1942 - Japanese attack Bataan in the Philippines.

January 11, 1942 - Japanese invade Dutch East Indies and Dutch Borneo.

January 16, 1942 - Japanese begin an advance into Burma.

January 18, 1942 - German-Japanese-Italian military agreement signed in Berlin.

January 19, 1942 - Japanese take North Borneo.

January 23, 1942 - Japanese take Rabaul on New Britain in the Solomon Islands and also invade Bougainville, the largest island.

January 27, 1942 - First Japanese warship sunk by a U.S. submarine.

January 30/31 - The British withdraw into Singapore. The siege of Singapore then begins.

February 1, 1942 - First U.S. aircraft carrier offensive of the war as YORKTOWN and ENTERPRISE conduct air raids on Japanese bases in the Gilbert and Marshall Islands.

February 2, 1942 - Japanese invade Java in the Dutch East Indies.

February 8/9 - Japanese invade Singapore.

February 14, 1942 - Japanese invade Sumatra in the Dutch East Indies.

February 15, 1942 - British surrender at Singapore.

February 19, 1942 - Largest Japanese air raid since Pearl Harbor occurs against Darwin, Australia; Japanese invade Bali.

February 20, 1942 - First U.S. fighter ace of the war, Lt. Edward O'Hare from the LEXINGTON in action off Rabaul.

February 22, 1942 - President Franklin D. Roosevelt orders General MacArthur out of the Philippines.

February 23, 1942 - First Japanese attack on the U.S. mainland as a submarine shells an oil refinery near Santa Barbara, California.

February 24, 1942 - ENTERPRISE attacks Japanese on Wake Island.

February 26, 1942 - First U.S. carrier, the LANGLEY, is sunk by Japanese bombers.

February 27- March 1 - Japanese naval victory in the Battle of the Java Sea as the largest U.S. warship in the Far East, the HOUSTON, is sunk.

March 4, 1942 - Two Japanese flying boats bomb Pearl Harbor; ENTERPRISE attacks Marcus Island, just 1000 miles from Japan.

March 7, 1942 - British evacuate Rangoon in Burma; Japanese invade Salamaua and Lae on New Guinea.

March 8, 1942 - The Dutch on Java surrender to Japanese.

March 11, 1942 - Gen. MacArthur leaves Corregidor and is flown to Australia. Gen. Jonathan Wainwright becomes the new U.S. commander.

March 18, 1942 - Gen. MacArthur appointed commander of the Southwest Pacific Theater by President Roosevelt.

March 18, 1942 - War Relocation Authority established in the U.S. which eventually will round up 120,000 Japanese-Americans and transport them to barb-wired relocation centers. Despite the internment, over 17,000 Japanese-Americans sign up and fight for the U.S. in World War II in Europe, including the 442nd Regimental Combat Team, the most decorated unit in U.S. history.

March 23, 1942 - Japanese invade the Andaman Islands in the Bay of Bengal.

March 24, 1942 - Admiral Chester Nimitz appointed as Commander in Chief of the U.S. Pacific theater.

April 3, 1942 - Japanese attack U.S. and Filipino troops at Bataan.

April 6, 1942 - First U.S. troops arrive in Australia.

April 9, 1942 - U.S. forces on Bataan surrender unconditionally to the Japanese.

April 10, 1942 - Bataan Death March begins as 76,000 Allied POWs including 12,000 Americans are forced to walk 60 miles under a blazing sun without food or water toward a new POW camp, resulting in over 5,000 American deaths.

April 18, 1942 - Surprise U.S. 'Doolittle' B-25 air raid from the HORNET against Tokyo boosts Allied morale.

April 29, 1942 - Japanese take central Burma.

May 1, 1942 - Japanese occupy Mandalay in Burma.

May 3, 1942 - Japanese take Tulagi in the Solomon Islands.

May 5, 1942 - Japanese prepare to invade Midway and the Aleutian Islands.

May 6, 1942 - Japanese take Corregidor as Gen. Wainwright unconditionally surrenders all U.S. And Filipino forces in the Philippines.

May 7-8, 1942 - Japan suffers its first defeat of the war during the Battle of the Coral Sea off New Guinea - the first time in history that two opposing carrier forces fought only using aircraft without the opposing ships ever sighting each other.

May 12, 1942 - The last U.S. Troops holding out in the Philippines surrender on Mindanao.

May 20, 1942 - Japanese complete the capture of Burma and reach India.

June 4-5, 1942 - Turning point in the war occurs with a decisive victory for the U.S. against Japan in the Battle of Midway as squadrons of U.S. torpedo planes and dive bombers from ENTERPRISE, HORNET, and YORKTOWN attack and destroy four Japanese carriers, a cruiser, and damage another cruiser and two destroyers. U.S. loses YORKTOWN.

June 7, 1942 - Japanese invade the Aleutian Islands.

June 9, 1942 - Japanese postpone further plans to take Midway.

July 21, 1942 - Japanese land troops near Gona on New Guinea.

August 7, 1942 - The first U.S. amphibious landing of the Pacific War occurs as 1st Marine Division invades Tulagi and Guadalcanal in the Solomon Islands.

August 8, 1942 - U.S. Marines take the unfinished airfield on Guadalcanal and name it Henderson Field after Maj. Lofton Henderson, a hero of Midway.

August 8/9 - A major U.S. naval disaster off Savo Island, north of Guadalcanal, as eight Japanese warships wage a night attack and sink three U.S. heavy cruisers, an Australian cruiser, and one U.S. destroyer, all in less than an hour. Another U.S. cruiser and two destroyers are damaged. Over 1,500 Allied crewmen are lost.

August 17, 1942 - 122 U.S. Marine raiders, transported by submarine, attack Makin Atoll in the Gilbert Islands.

August 21, 1942 - U.S. Marines repulse first major Japanese ground attack on Guadalcanal.

August 24, 1942 - U.S. And Japanese carriers meet in the Battle of the Eastern Solomons resulting in a Japanese defeat.

August 29, 1942 - The Red Cross announces Japan refuses to allow safe passage of ships containing supplies for U.S. POWs.

August 30, 1942 - U.S. Troops invade Adak Island in the Aleutian Islands.

September 9/10 - A Japanese floatplane flies two missions dropping incendiary bombs on U.S. forests in the state of Oregon - the only bombing of the continental U.S. during the war. Newspapers in the U.S. voluntarily withhold this information.

September 12-14 - Battle of Bloody Ridge on Guadalcanal.

September 15, 1942 - A Japanese submarine torpedo attack near the Solomon Islands results in the sinking of the Carrier WASP, Destroyer O'BRIEN and damage to the Battleship NORTH CAROLINA.

September 27, 1942 - British offensive in Burma.

October 11/12 - U.S. cruisers and destroyers defeat a Japanese task force in the Battle of Cape Esperance off Guadalcanal.

October 13, 1942 - The first U.S. Army troops, the 164th Infantry Regiment, land on Guadalcanal.

October 14/15 - Japanese bombard Henderson Field at night from warships then send troops ashore onto Guadalcanal in the morning as U.S. planes attack.

October 15/17 - Japanese bombard Henderson Field at night again from warships.

October 18, 1942 - Vice Admiral William F. Halsey named as the new commander of the South Pacific Area, in charge of the Solomons-New Guinea campaign.

October 26, 1942 - Battle of Santa Cruz off Guadalcanal between U.S. And Japanese warships results in the loss of the Carrier HORNET.

November 14/15 - U.S. And Japanese warships clash again off Guadalcanal resulting in the sinking of the U.S. Cruiser JUNEAU and the deaths of the five Sullivan brothers.

November 23/24 - Japanese air raid on Darwin, Australia.

November 30/31 - Battle of Tasafaronga off Guadalcanal.

December 2, 1942 - Enrico Fermi conducts the worlds first nuclear chain reaction test at the University of Chicago.

December 20-24 - Japanese air raids on Calcutta, India.

December 31, 1942 - Emperor Hirohito of Japan gives permission to his troops to withdraw from Guadalcanal after five months of bloody fighting against U.S. Forces

1943

January 2, 1943 - Allies take Buna in New Guinea.

January 22, 1943 - Allies defeat Japanese at Sanananda on New Guinea.

February 1, 1943 - Japanese begin evacuation of Guadalcanal.

February 8, 1943 - British-Indian forces begin guerrilla operations against Japanese in Burma.

February 9, 1943 - Japanese resistance on Guadalcanal ends.

March 2-4 - U.S. victory over Japanese in the Battle of Bismarck Sea.

April 18, 1943 - U.S. code breakers pinpoint the location of Japanese Admiral Yamamoto flying in a Japanese bomber near Bougainville in the Solomon Islands. Eighteen P-38 fighters then locate and shoot down Yamamoto.

April 21, 1943 - President Roosevelt announces the Japanese have executed several airmen from the Doolittle Raid.

April 22, 1943 - Japan announces captured Allied pilots will be given "one way tickets to hell."

May 10, 1943 - U.S. Troops invade Attu in the Aleutian Islands.

May 14, 1943 - A Japanese submarine sinks the Australian hospital ship CENTAUR resulting in 299 dead.

May 31, 1943 - Japanese end their occupation of the Aleutian Islands as the U.S. completes the

capture of Attu.

June 1, 1943 - U.S. begins submarine warfare against Japanese shipping.

June 21, 1943 - Allies advance to New Georgia, Solomon Islands.

July 8, 1943 - B-24 Liberators flying from Midway bomb Japanese on Wake Island.

August 1/2 - A group of 15 U.S. PT-boats attempt to block Japanese convoys south of Kolombangra Island in the Solomon Islands. PT-109, commanded by Lt. John F. Kennedy, is rammed and sunk by the Japanese Cruiser AMAGIRI, killing two and badly injuring others. The crew survives as Kennedy aids one badly injured man by towing him to a nearby atoll.

August 6/7, 1943 - Battle of Vella Gulf in the Solomon Islands.

August 25, 1943 - Allies complete the occupation of New Georgia.

September 4, 1943 - Allies recapture Lae-Salamaua, New Guinea.

October 7, 1943 - Japanese execute approximately 100 American POWs on Wake Island.

October 26, 1943 - Emperor Hirohito states his country's situation is now "truly grave."

November 1, 1943 - U.S. Marines invade Bougainville in the Solomon Islands.

November 2, 1943 - Battle of Empress Augustusta Bay.

November 20, 1943 - U.S. Troops invade Makin and Tarawa in the Gilbert Islands.

November 23, 1943 - Japanese end resistance on Makin and Tarawa.

December 15, 1943 - U.S. Troops land on the Arawe Peninsula of New Britain in the Solomon Islands.

December 26, 1943 - Full Allied assault on New Britain as 1st Division Marines invade Cape Gloucester.

1944

January 9, 1944 - British and Indian troops recapture Maungdaw in Burma.

January 31, 1944 - U.S. Troops invade Kwajalein in the Marshall Islands.

February 1-7, 1944 - U.S. Troops capture Kwajalein and Majura Atolls in the Marshall Islands.

February 17/18 - U.S. Carrier-based planes destroy the Japanese naval base at Truk in the Caroline Islands.

February 20, 1944 - U.S. Carrier-based and land-based planes destroy the Japanese base at Rabaul.

February 23, 1944 - U.S. Carrier-based planes attack the Mariana Islands.

February 24, 1944 - Merrill's Marauders begin a ground campaign in northern Burma.

March 5, 1944 - Gen. Wingate's groups begin operations behind Japanese lines in Burma.

March 15, 1944 - Japanese begin offensive toward Imphal and Kohima.

April 17, 1944 - Japanese begin their last offensive in China, attacking U.S. air bases in eastern China.

April 22, 1944 - Allies invade Aitape and Hollandia in New Guinea.

May 27, 1944 - Allies invade Biak Island, New Guinea.

June 5, 1944 - The first mission by B-29 Superfortress bombers occurs as 77 planes bomb Japanese railway facilities at Bangkok, Thailand.

June 15, 1944 - U.S. Marines invade Saipan in the Mariana Islands.

June 15/16 - The first bombing raid on Japan since the Doolittle raid of April 1942, as 47 B-29s

based in Bengal, India, target the steel works at Yawata.
June 19, 1944 - The "Marianas Turkey Shoot" occurs as U.S. Carrier-based fighters shoot down 220 Japanese planes, while only 20 American planes are lost.
July 8, 1944 - Japanese withdraw from Imphal.
July 19, 1944 - U.S. Marines invade Guam in the Marianas.
July 24, 1944 - U.S. Marines invade Tinian.
July 27, 1944 - American troops complete the liberation of Guam.
August 3, 1944 - U.S. And Chinese troops take Myitkyina after a two month siege.
August 8, 1944 - American troops complete the capture of the Mariana Islands.
September 15, 1944 - U.S. Troops invade Morotai and the Paulaus.
October 11, 1944 - U.S. Air raids against Okinawa.
October 18, 1944 - Fourteen B-29s based on the Marianas attack the Japanese base at Truk.
October 20, 1944 - U.S. Sixth Army invades Leyte in the Philippines.
October 23-26 - Battle of Leyte Gulf results in a decisive U.S. Naval victory.
October 25, 1944 - The first suicide air (Kamikaze) attacks occur against U.S. warships in Leyte Gulf. By the end of the war, Japan will have sent an estimated 2,257 aircraft. "The only weapon I feared in the war," Adm. Halsey will say later.
November 11, 1944 - Iwo Jima bombarded by the U.S. Navy.
November 24, 1944 - Twenty four B-29s bomb the Nakajima aircraft factory near Tokyo.
December 15, 1944 - U.S. Troops invade Mindoro in the Philippines.
December 17, 1944 - The U.S. Army Air Force begins preparations for dropping the Atomic Bomb by establishing the 509th Composite Group to operate the B-29s that will deliver the bomb.

1945

January 3, 1945 - Gen. MacArthur is placed in command of all U.S. ground forces and Adm. Nimitz in command of all naval forces in preparation for planned assaults against Iwo Jima, Okinawa and Japan itself.
January 4, 1945 - British occupy Akyab in Burma.
January 9, 1945 - U.S. Sixth Army invades Lingayen Gulf on Luzon in the Philippines.
January 11, 1945 - Air raid against Japanese bases in Indochina by U.S. Carrier-based planes.
January 28, 1945 - The Burma road is reopened.
February 3, 1945 - U.S. Sixth Army attacks Japanese in Manila.
February 16, 1945 - U.S. Troops recapture Bataan in the Philippines.
February 19, 1945 - U.S. Marines invade Iwo Jima.
March 1, 1945 - A U.S. submarine sinks a Japanese merchant ship loaded with supplies for Allied POWs, resulting in a court martial for the captain of the submarine, since the ship had been granted safe passage by the U.S. Government.
March 2, 1945 - U.S. airborne troops recapture Corregidor in the Philippines.
March 3, 1945 - U.S. And Filipino troops take Manila.
March 9/10 - Fifteen square miles of Tokyo erupts in flames after it is fire bombed by 279 B-29s.
March 10, 1945 - U.S. Eighth Army invades Zamboanga Peninsula on Mindanao in the

Philippines.

March 20, 1945 - British troops liberate Mandalay, Burma.

March 27, 1945 - B-29s lay mines in Japan's Shimonoseki Strait to interrupt shipping.

April 1, 1945 - The final amphibious landing of the war occurs as the U.S. Tenth Army invades Okinawa.

April 7, 1945 - B-29s fly their first fighter-escorted mission against Japan with P-51 Mustangs based on Iwo Jima; U.S. Carrier-based fighters sink the super battleship YAMATO and several escort vessels which planned to attack U.S. Forces at Okinawa.

April 12, 1945 - President Roosevelt dies, succeeded by Harry S. Truman.

May 8, 1945 - Victory in Europe Day.

May 20, 1945 - Japanese begin withdrawal from China.

May 25, 1945 - U.S. Joint Chiefs of Staff approve Operation Olympic, the invasion of Japan, scheduled for November 1.

June 9, 1945 - Japanese Premier Suzuki announces Japan will fight to the very end rather than accept unconditional surrender.

June 18, 1945 - Japanese resistance ends on Mindanao in the Philippines.

June 22, 1945 - Japanese resistance ends on Okinawa as the U.S. Tenth Army completes its capture.

June 28, 1945 - MacArthur's headquarters announces the end of all Japanese resistance in the Philippines.

July 5, 1945 - Liberation of Philippines declared.

July 10, 1945 - 1,000 bomber raids against Japan begin.

July 14, 1945 - The first U.S. Naval bombardment of Japanese home islands.

July 16, 1945 - First Atomic Bomb is successfully tested in the U.S.

July 26, 1945 - Components of the Atomic Bomb "Little Boy" are unloaded at Tinian Island in the South Pacific.

July 29, 1945 - A Japanese submarine sinks the Cruiser INDIANAPOLIS resulting in the loss of 881 crewmen. The ship sinks before a radio message can be sent out leaving survivors adrift for two days.

August 6, 1945 - First Atomic Bomb dropped on Hiroshima from a B-29 flown by Col. Paul Tibbets.

August 8, 1945 - U.S.S.R. declares war on Japan then invades Manchuria.

August 9, 1945 - Second Atomic Bomb is dropped on Nagasaki from a B-29 flown by Maj. Charles Sweeney -- Emperor Hirohito and Japanese Prime Minister Suzuki then decide to seek an immediate peace with the Allies.

August 14, 1945 - Japanese accept unconditional surrender; Gen. MacArthur is appointed to head the occupation forces in Japan.

August 16, 1945 - Gen. Wainwright, a POW since May 6, 1942, is released from a POW camp in Manchuria.

August 27, 1945 - B-29s drop supplies to Allied POWs in China.

August 29, 1945 - The Soviets shoot down a B-29 dropping supplies to POWs in Korea; U.S. Troops land near Tokyo to begin the occupation of Japan.

August 30, 1945 - The British reoccupy Hong Kong.

September 2, 1945 - Formal Japanese surrender ceremony on board the MISSOURI in Tokyo Bay as 1,000 carrier-based planes fly overhead; President Truman declares VJ Day.

September 3, 1945 - The Japanese commander in the Philippines, Gen. Yamashita, surrenders to Gen. Wainwright at Baguio.

September 4, 1945 - Japanese troops on Wake Island surrender.

September 5, 1945 - British land in Singapore.

September 8, 1945 - MacArthur enters Tokyo.

September 9, 1945 - Japanese in Korea surrender.

September 13, 1945 - Japanese in Burma surrender.

October 24, 1945 - United Nations is born.

Map of the Japanese Empire at its peak in 1942.



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