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An amputation being performed in a hospital tent during the Battle of Gettysburg. Courtesy of the Department of the Interior, National Park Service

Orthopedic Surgery during the American Civil War

TONY FORGIONE, CST, LPN

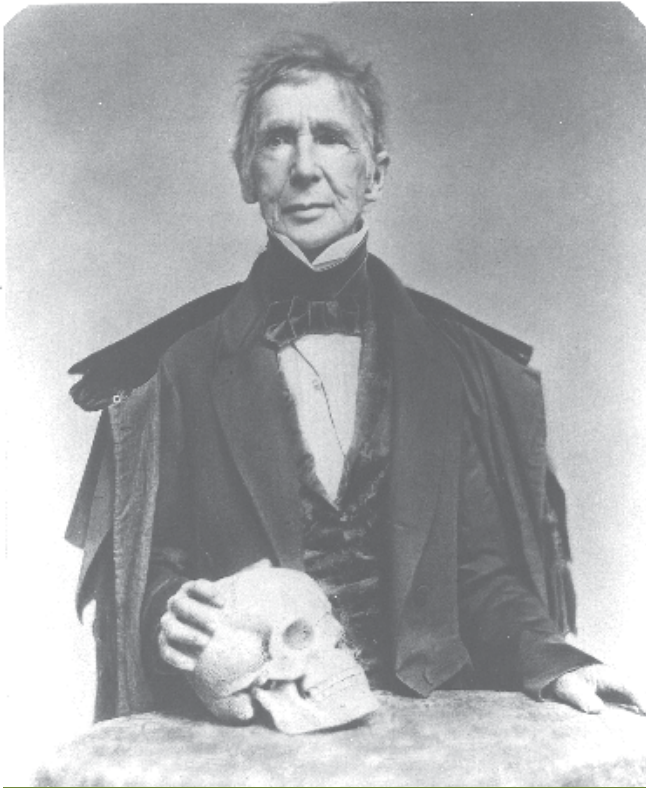
Surgery during the American Civil War, as portrayed in movies, was an exercise in torture. The scene from the movie "The Horse Soldiers" shows where the actor, William Holden, had to amputate the infected leg of a union soldier. The surgery took place on the hay-strewn floor of a horse stall and the only method of anesthesia that was available was a bottle of whiskey and four strong soldiers to hold the patient down. The film's portrayal was far from reality.

The use of anesthetic agents in surgery was first successfully introduced in 1846 at the Massachusetts General Hospital (MGH) when Dr William Morton used ether as an anesthetic while doctors John C Warren and Henry J Bigelow performed a neck dissection on a patient. The patient reported a complete absence of pain during the procedure. Dr Warren was quoted as saying, "Gentlemen, this is no humbug."

The use of anesthetics had a profound effect on the number of future surgical procedures. At MGH, during the years of 1839-1846 there were a total of only 39 surgical procedures performed. However, during the 10 years following, the number of surgical procedures increased to 189 cases.

LEARNING OBJECTIVES

- ▲ Learn about the battlefield conditions doctors had to deal with during the Civil War
- ▲ Identify the three categories doctors established to help treat patients
- ▲ Examine what caused the majority of injuries during the battle
- ▲ Discuss the various methods used by surgeons to mend gunshot wounds
- ▲ Read about the influential people who made anesthesia, orthopedic surgery and prosthetics what they are today



Dr John Collins Warren, (1778–1856) who co-founded Mass General Hospital with Dr James Jackson in 1811, was the surgeon at the first public demonstration of surgical anesthesia in 1846.

The 19th century has been described as the “medical dark ages.” Surgeons during this time had no standards for what caused infections, effective sterilization techniques and proper sanitary conditions.

MEDICAL TRAINING

Medical training during the 19th century consisted of students attending a two-year program. In the first year, students attended lectures. The second year also consisted of lectures, and in many cases, the lectures were the same as the year before. Medical students received no laboratory training and had no hands-on clinical experience with

patients. Once they graduated they had to find jobs working with a practicing surgeon who would agree to take them on as his apprentice. They were exposed to patients during this time and began assisting the surgeon with surgeries. Once they acquired an adequate number of years working with a surgeon, they were able to set up their own medical practice.

The 19th century has been described as the “medical dark ages.” Surgeons during this time had no standards for what caused infections, effective sterilization techniques and proper sanitary conditions. Before the start of the Civil War many surgeons never had treated a gunshot wound. When the war started, surgeons were immediately faced with a lack of supplies, a lack of proper shelter and clothing and overcrowded conditions.

“Hospitals were sometimes overwhelmed by the major battle casualties.

The limited number of surgeons worked around the clock.”

FIELD HOSPITAL CONDITIONS

To further compound the dire situation, many of those who were wounded on the battlefield remained there long after hostilities ended. This unfortunate condition was documented in a communication in August 1862 after the Second Battle of Manassas from the Surgeon General William Hammond to the Secretary of War Edwin Stanton:

“Up to this date, 600 wounded still remain on the battlefield

Many have died of starvation; many more will die in consequence

Of exhaustion, and all have endured torments which might have been avoided.”

To try to rectify this deplorable situation, Hammond selected Jonathan Letterman as the new medical director of the Army of the Potomac. Letterman established the Ambulance Corps. This service consisted of able-bodied soldiers who were assigned to three ambulances for a regiment of approximately 1,000 soldiers. The horse-drawn ambulances could carry a total of four soldiers on stretchers to field hospitals. The field hospitals were established in any available building and/or field that were considered to be a safe distance from the battlefield. The ride, though sometimes only a few miles, was extremely bumpy and painful for the wounded individuals.

However, the wounded soldiers were not any better than



A Re-enactment of the October 16, 1846, ether operation.

they were before they were removed from the battlefield. The field hospitals were overcrowded, lacked proper hygiene and sanitary conditions and held an inadequate supply of clothing, food and water.

CASUALTIES DURING THE WAR

The following table breaks down the total casualties during the armed conflict.^x

Casualties	Confederate	Union
Battle Deaths	94,000	110,070
Diseases	164,000	250,152
Total	258,000	360,222

Most of the battle casualties were from small arms ammunition, resulting in 94% of the casualties inflicted. Artillery wounds accounted for 5.5%, and only 0.4% was caused by

bayonet or saber stokes. The gunshot wounds produced large gaping wounds that resulted in massive soft tissue damage and shattered bones. Of all the injuries recorded, 70% involved extremities that usually included bone damage. The Minié bullet was to blame for this type of destruction. The Minié was developed by Claude-Etienne Minié and introduced in 1849. It was cylindrical in shape with a hollow base, weighed 1.05 ounces and was extremely accurate, although it was considered a slow-moving bullet, traveling only 950 feet per second when fired.

TREATING ORTHOPEDIC INJURIES

Casualties during the Civil War were broken down into three categories. The first involved injuries that did not require any surgical intervention. These patients were treated in a more conservative method. For an upper arm injury, the surgeon would apply a Velpeau sling. Patients with lower extremity injuries who did not need surgery would be placed in a Buck's traction. Soldiers would need to remain in traction for a number of weeks to allow their broken bones to heal.

ADVANCEMENT OF ARTIFICIAL LIMBS

The after-effects of the Civil War produced a vast demand for artificial limbs. It was reported that around 35,000 survivors were amputees.¹

One soldier who was in need of a prosthetic was James Edward Hanger. James was a sophomore studying engineering at Washington College when the war started. At that time, he left college to enlist, joining a cavalry unit. During his second day as a soldier, in June 1861, a Union cannonball struck his left leg below the knee while he was camped out at a stable. The incident smashed his left leg. He was badly wounded and was captured and taken to a Union hospital where a surgeon had to amputate his leg. James Hanger became the first documented amputation of the Civil War.² A few months later, James was exchanged in a prisoner swap and was sent home.

Once at home, James isolated himself in his room much to the worry of his family. He kept asking for wood, leather and rubber and slowly developed an artificial leg with two articulating joints. A patent record for patent number 155, was noted by the Confederate Patent Office on March 23, 1863.²

His success with this limb led him to start his own company, the JE Hanger Company out of Richmond, VA. His unique design caught the attention of the Virginia legislature who commissioned him to provide artificial limbs for returning Virginia veterans.²

Today, the company is still in existence as the Hanger Orthopedic Group, Inc. It is a multimillion-dollar corporation with centers in 45 states.²

Reference

1. Oatman-Stanford, H. War and Prosthetics. How Veterans Fought for the Perfect Artificial Limb. October 2012. Collectors Weekly. <http://www.collectorsweekly.com/articles/war-and-prosthetics/> Accessed October 2014.
2. James Edward Hanger. Find a Grave. <http://www.findagrave.com/cgi-bin/fg.cgi?page=gr&GRid=86673541> Accessed October 2014.

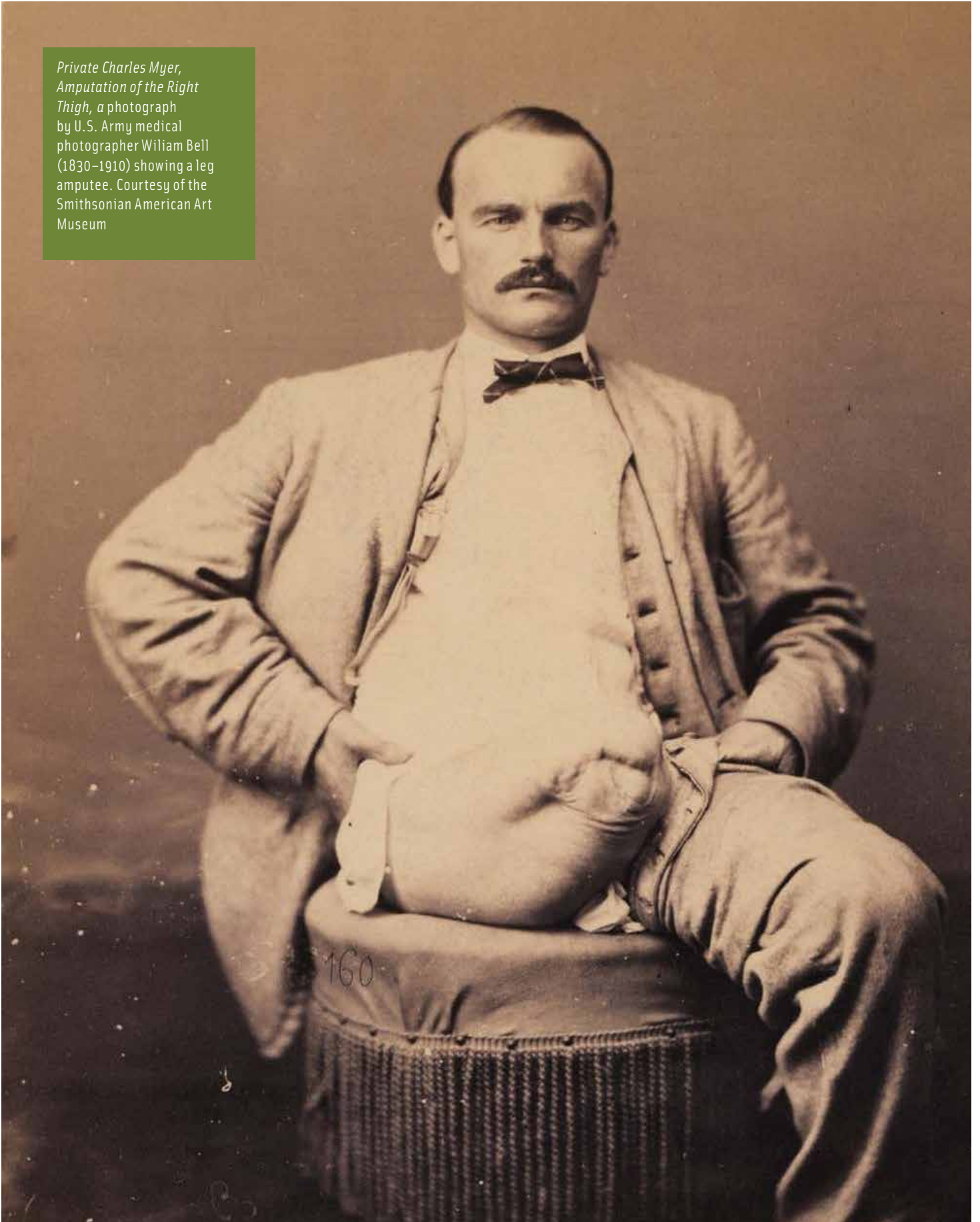
The second injury category involved the first attempts at saving limbs. The surgeon would remove the tissue in the immediate area of the gunshot wound, as well as damaged bone in an effort to allow healing to take effect. However, according to Julian Kuz, the resulting instability and pain would prevent soldiers from being able to walk.

The final category for treating broken bones was to amputate the affected limb. During this time, there was no viable method for the reduction of broken bones in field hospitals. Each potential case was reviewed by a panel of surgeons who would make a decision regarding whether or not to amputate. The procedure was performed by a senior surgeon who was separate from the decision-making panel. The military medical corps felt this method would eliminate needless amputations. Records indicate that there were at least 50,000 amputations performed during the war.

Of all the injuries recorded, 70% involved extremities that usually included bone damage. The Minié bullet was to blame for this type of destruction. ... It was cylindrical in shape with a hollow base, weighed 1.05 ounces and was extremely accurate, although it was considered a slow-moving bullet, traveling only 950 feet per second when fired.

The procedure, by today's standards, was primitive. The surgeon would probe the wound with his fingers or a blunt instrument, and a tourniquet would be applied to reduce the loss of blood. The surgeon would use a Lister amputation knife and cut through the skin, underlying tissue and muscles to expose the bone. He would use an amputation saw to remove the bone, and retraction would be supplied by the hands of his assistants. A file was used to smooth sharp edges of the bone. Bleeding was controlled by tying off the ends of the blood vessels with cotton or silk thread. The muscles and tissue were then sewn over the end of the amputated extremity and the skin edges were loosely approximated together. The average length of time for an

Private Charles Myer, Amputation of the Right Thigh, a photograph by U.S. Army medical photographer William Bell (1830–1910) showing a leg amputee. Courtesy of the Smithsonian American Art Museum



amputation was 10 to 15 minutes.

There were three different techniques utilized for amputations: the oval technique, the circular incision and the flap operation. Most surgeons used the flap technique because it provided a cushion for future fittings for a prosthetic device.

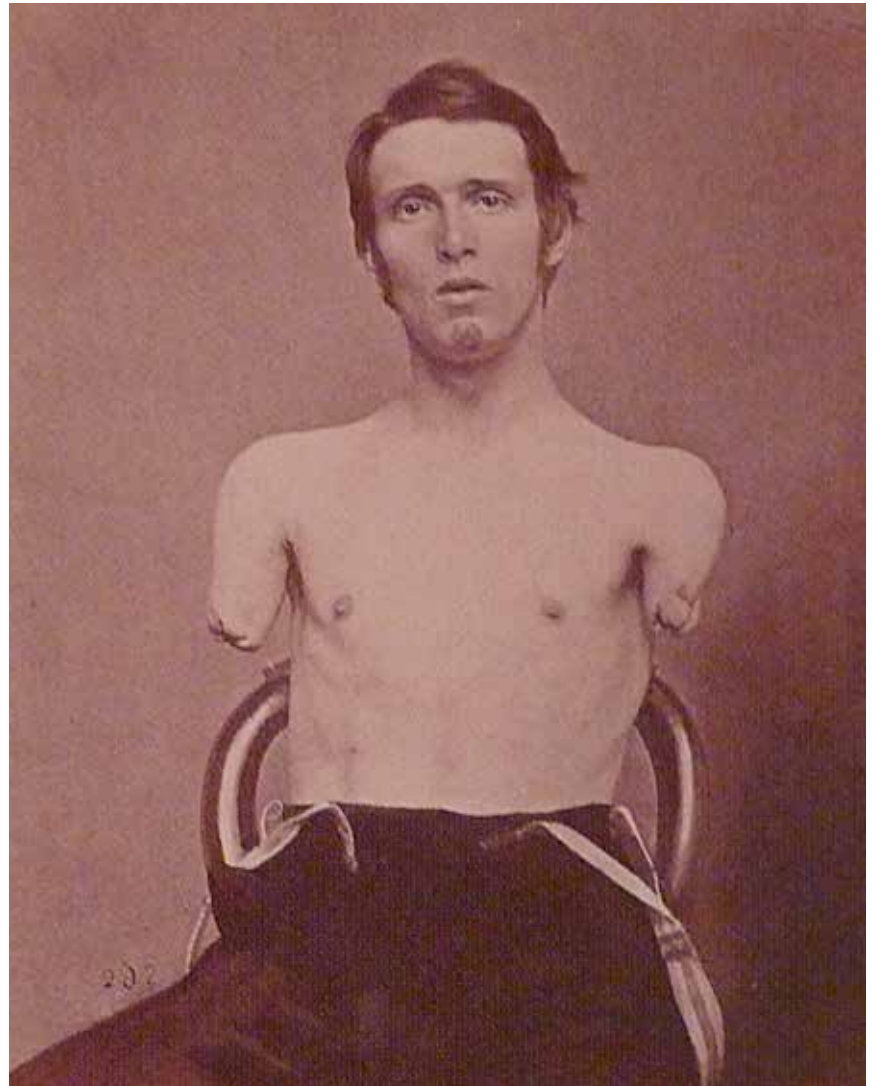
When the patient was strong enough to travel, they were sent to a military hospital or returned to their home for recuperation.

OPEN REDUCTION INTERNAL FIXATION

According to Kuz, during the Civil War the first attempts to perform an open resection internal fixation of fractured bones were performed by Dr Benjamin Howard. He has been credited with performing three of the four recorded such cases. To further complicate his efforts, he performed the surgery while the wounded soldier was still on the battlefield. Dr Howard felt there was too much pain experienced by wounded soldiers as they were transported to the field hospital. He also felt that there was the potential for further damage if soldier's broken bones were not stabilized. He proposed his method would help prevent, "Such painful and dangerous motion of the fractured ends of the bone en route to general hospital."

His method consisted of enlarging the wound for

adequate access, and then he "removed all the detritus and loose fragments" Dr Howard then mated the ends of the fractured bones by using a metacarpal



Alfred A Stratton lost both his arms at age 19 on June 18, 1864, by a cannon shot during the American Civil War. The amputation was performed by AS Coe. Stratton died as a father of two at the age of 29.

The after-effects of the Civil War produced a vast demand for artificial limbs. It was reported that around 35,000 survivors were amputees.¹



Instrument case for amputation during Civil War. Courtesy of Naval History & Heritage Command

saw to remove the ends of the bone that created “the least possible shortening compatible with clean-fitting surfaces.” Using a device of his own making, Dr Howard drilled two pairs of holes through the proximal and distal bones and passed a suture of stout annealed iron wire to reduce and secure the bone edges. The amount of bone that Dr Howard had to excise was considerable, yet effective.

Though an open reduction internal fixation procedure is a standard orthopedic operation today, Dr Howard’s methods were not embraced by the medical profession. His colleagues objected to placing a foreign substance into a wound.

Orthopedics was not officially recognized until 1887 when the American Orthopedic Association was founded. However, the foundations of this specialty were practiced by many pioneering surgeons who recognized the importance of restoring proper function to patient’s broken bones, foundations that still influence today’s orthopedic protocols.



ABOUT THE AUTHOR

Tony Forgione, CST, LPN, has almost 40 years of experience as a surgical technologist. His career has spanned from the US Navy to the Massachusetts General Hospital, where he continues to work. Tony is also the Supervisory Oper-

ating Room Nurse for the International Medical Surgical Response Team (IMSuRT), a federally mandated disaster team. In addition, he earned a Bachelor’s degree in history from the University of Massachusetts at Boston. Tony spent 20 years demonstrating his interest in history as a Civil War reenactor.

REFERENCES

1. Bull, W; Bull, M. Something in the Ether: A Bicentennial History of Massachusetts General Hospital, 1811 – 2011. Memoires Unlimited, April 2011.
2. Cohen, D. Orthopedics at War. www.CivilWarMedicine\OrthopedicsatWar.html Accessed September 2014.
3. Freemon, FB; Gangrene and Glory: Medical Care during the American Civil War.” University of Illinois Press. Chicago. 2001.
4. Hammond to Stanton, September 7, 1862. Secretary of War Correspondence, National Archives. Reproduced in MSH. Surgical Volume (3): 394.
5. Howard, B, MD. “The Application of Sutures to Bone in Recent Gun-Shot Fractures.” Medico-Chirurgical Transactions, 1865; 245-253.
6. Billings, JS, MD. Letter to his wife from the field hospital in Gettysburg, Pennsylvania.
7. Kuz, J, MD; Bengtson, B, MD. Orthopedic Injuries of the Civil War. Kennesaw Mountain Press. Kennesaw, 1996.

The Surgical Legacy of World War II

Part 1: Pearl Harbor, Preparation and Portability

DOLORES GOYETTE, CST, DC

AUTHOR'S NOTE:

As our nation remembers the 75th anniversary of the Japanese attack on Pearl Harbor on December 7, 1941 – “a day which will live in infamy” – we should acknowledge the contributions of the outstanding World War II medical personnel, whose incredible vision, intensive planning and heroic efforts gave the wounded an extraordinary chance of survival. Among them are distinguished military surgeons, whose experiences inspired them to invent and implement methods and instruments we know the names of because they are used every day in modern ORs. Yet, there are countless names not mentioned here – men and women of all races, ranks and occupations, whose contributions are no less important to the effort to mitigate human suffering, and who are profoundly worthy of being remembered. Why should we, as working CSTs care about this increasingly distant history? Because, the surgical technology profession can trace its inception to this period in American history – as the military planned for, and then entered – the first truly global conflict.

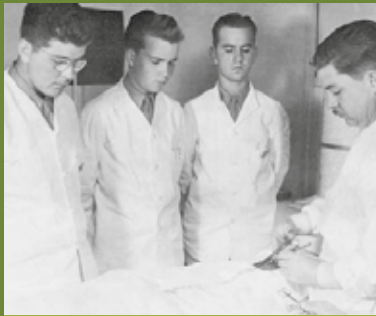
This series of articles will provide an overview of the key surgical developments of World War II. The story begins with the tactical and medical planning and build-up prior to America’s formal entry into the war following the attack on Pearl Harbor. Despite the political necessity of maintaining a congressional-led national policy of neutrality, President Franklin D Roosevelt and his cabinet quietly, but unswervingly, worked to prepare the nation for war. While much has been made of the nation’s industrial base shifting into the manufacture of weapons and vehicles, little is commonly known about the preparations for the massive number of expected casualties.

LEARNING OBJECTIVES

- ▲ Review the medical advancements that were made as a result of the Pearl Harbor attack
- ▲ Explore how WWII impacted the surgical profession
- ▲ Recall how the role of the surgical technologist became to be
- ▲ Discuss how the MASH unit was created
- ▲ Learn about the logistic complications that confronted medical personnel during the wars

SNAPSHOT: THE FIRST SURGICAL TECHNOLOGISTS

The Medical Department Enlisted Technicians Schools from 1940 until the end of the war trained more than 43,000 men and women as surgical "technicians." MDETS around the country prepared the STs for their role in the ORs as well as the basics of being in military service.



Surgical technicians in training at Letterman General Hospital in San Francisco in 1943

In 1942, an advanced program was established for the highest-skilled techs. They were sent for another three months of surgical training in a hospital setting, in a curriculum that looks a lot like today's programs with class-

room time and hospital hours where students logged a variety of surgical cases and time in the wards. The program was a huge success and was intended to supplement or replace nurses in the forward areas of battle and in the hospital units.



A surgical technician is shown sterilizing instruments in a portable autoclave

room time and excelling on the job, the Army relied heavily upon male STs near the front line. They could be sent alongside platoons to function as company aidmen when not in the operating room, and were responsible for carrying enormous amounts of heavy equipment.

During WWII and to this day, STs represent an essential part of the fixed and mobile hospital systems in all theatres of operation.

GEO-POLITICS BEFORE WWII: AN UNSTABLE TIME

The years preceding the surprise attack on Pearl Harbor (and other bases) represent a highly unstable time across the globe. The period between 1918 and 1936 saw the rise of destructive international leaders in both Europe and the Pacific and failure of the World War I peace treaties. Memories were still fresh of a devastating war that had just ended, which had ravaged much of continental Europe. The Japanese-Russian War (1904-1905) was still reverberating in the Pacific, as this was the first time an Asian nation had defeated one of the European powers since the dawn of European colonialism.

War was brewing even though US citizens were strongly opposed to getting involved. By the 1930s, naked aggression and outright atrocities by recently aligned Germany, Italy and Japan created unbearable political tensions in Asia and Europe. The United States' historic allies, France and England, were unable to remain neutral despite repeated capitulation to Germany and others' incursions across Europe. In September 1939, they found themselves at war with Germany over the Germans invasion of Poland.

When America declared war on Japan after its brutal attack on the US at Pearl Harbor in the Hawaii Islands and on the Philippines on December 7, 1941, the world was already embroiled in violence and turmoil. Within days, there were counter-declarations of war across the globe, and Americans entered into war for the second time in a generation.

The decades after World War I had produced significant advances in blood banking and the preservation of plasma. Doctors were gaining a better understanding of how to use morphine and antibiotics. Recognition that, historically, more soldiers died from disease than from battle, rapid improvement in vaccination programs and the discovery of antimalarial drugs were lifesaving advances, also. Yet, combat surgery had enormous hurdles still to overcome, and so the Surgeon General had decided that recruiting the best doctors in the US would be a priority in the war on casualties.

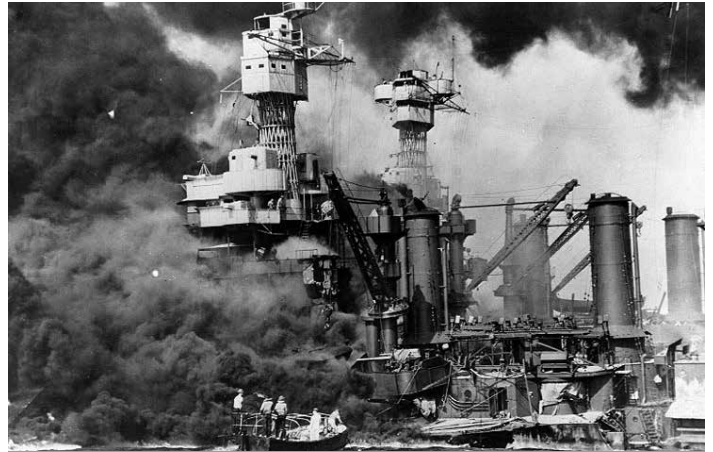
PREPARING FOR CASUALTIES

World War II would bring fighting to all reaches of the globe, and the US found itself facing significant questions as to how to treat casualties in several distinct geographical areas. War in Europe would provide access to interconnected roads, bridges, ports, railways and airfields that could be used to move patients within hospital networks. Going to war with Japan meant fighting across one-third of the Earth's surface, the vast majority of which was water, from tropical islands and Asian jungles to the Alaskan peninsula. A huge, adaptable and mobile force of medical personnel and material would be required to treat the wounded, and it was a monumental task to determine how to get them and all of their equipment to each far-flung battle zone. As was important in earlier parts of the century, the Hawaiian Islands had become a critical staging area for military and medical preparation. Pearl Harbor and the island of Oahu was home to more than 100 ships, dozens of aircraft and 51,000 Army, Navy, Marine and Air Corps personnel between 1936 and December 1941. These numbers grew exponentially during the war years.

THE PEARL HARBOR TRAGEDY

The two-hour attack by the Japanese on Pearl Harbor killed 2,403 Americans, sunk or damaged almost 20 US Navy ships and destroyed almost 200 US planes at the Naval and Army air bases nearby. The coordinated assault began at 7:45 am on a Sunday morning, and by 8:15 am, massive numbers of casualties began pouring into hospitals near the bases. Soon the wounded would arrive at other treatment centers around the island. Quick access to treatment in the golden period of time (then thought to be six hours) is cited as a leading factor in achieving a 3.8% postoperative mortality rate following the attack — a remarkable accomplishment given the surprise nature of the attack.

Thankfully, the Naval Hospital Pearl Harbor (NHPH) was only slightly damaged in



On December 7, 1941, the Japanese military launched a surprise attack on the United States Naval Base at Pearl Harbor, Hawaii

the attack, and the Navy Mobile Hospital #2 (NMH) had been unloaded on the base and was partially uncrated. The NHPH alone received 546 casualties and 313 dead in the first three hours after the attack, and by the end of the day, would treat almost 1,000 patients.

Impressively, 110 patients were treated in the swiftly-completed mobile hospital. While not comprised of canvas tents, the Navy Mobile Hospital was essentially a kit containing lightweight walls and portable versions of necessary equipment. The entire NMH was assembled by the doctors, nurses and enlisted men who would soon be working inside the mobile facility. The lessons learned from labeling,



Mobile Hospital #2, Pearl Harbor, Hawaii

Navy Medicine Historical Files Collection

unpacking and setting up the mobile hospital following the attack on Pearl Harbor became invaluable during the fighting in the Pacific islands and in Europe.

Any non-injured military medical personnel, from any branch of service, reported to the NHPH to assist in caring for the wounded. Civilians from all over Oahu disregarded their own safety to help transport the wounded. Serendipitously, the Honolulu Medical Society was hosting a con-

operating around the clock.

Burn victims dominated the casualties during the morning of the attack. Sixty percent of the injuries were either flash burns (analogous to a bad sunburn with widespread first- and second-degree burns from exposure to extreme heat) or more severe burns from being thrown into the harbor where fuel flamed on the surface of the water. The viscous fuel oil covered the men from head to toe and contributed to the severity of the burn and made treatment extremely difficult. Many of the burn victims were treated on a Navy hospital ship in the harbor.

Dangerously, the admitting process was skipped entirely at shore hospitals because such an enormous number of casualties arrived simultaneously. The burn wounds created a great challenge of identification. Since the attack occurred on a Sunday, many of the men were off or enjoying a slower pace to their when the raid began. Many of them didn't have their personalized uniforms or metal ID tags on them when they were brought in for treatment. Their clothing was burned off, and so too were their fingerprints as their hands were scorched. Many of the injured arrived in an unconscious state, to a facility not near their assigned duty station and did not survive their surgeries. The US Navy had to create "unknown" graves, but recently has been exhuming remains and applying DNA technology to properly identify those who died and give their gravesites respective markings.

Compound fractures, shrapnel wounds and amputations were the other significant categories for the remainder of the injuries. Those were the cases to which civilian

The two-hour attack by the Japanese on Pearl Harbor killed 2,403 Americans, sunk or damaged almost 20 US Navy ships and destroyed almost 200 US planes at the Naval and Army air bases nearby.

ference on trauma surgery on the weekend of the attack. More than 300 civilian and military medical personnel had gathered to hear John J Moorhead, a prominent WWI surgeon speak. Dr Moorhead and every one of the assembled doctors rushed to the NHPH to help when they heard the news, and then rapidly made their way to the base and the other hospitals on the island and spent the next several days

SNAP SHOT: BIRTH OF MODERN ANESTHESIOLOGY

Ether was an important anesthetic agent in frontline surgeries of WWII. It was easy to carry and administer, but it was highly flammable and known to cause respiratory paralysis. Often times, supplies were interrupted and ran desperately low.

IV Pentothal was widely available, but had its own hazards. By the end of the war, endotracheal intubation would become the enduring standard in anesthesiology. The Miller (1941) and MacIntosh (1943) laryngoscopes advanced tracheal visualization for airway management for the anesthetist.

The year 1942 brought another development when Harold Griffith, MD, of Montreal, Canada, introduced the use of Intocostrin (curare, a muscle relaxant) during surgery. Longer surgeries became possible and surgery became safer than ever before. Although it would take time for these advancements to get to the front lines of battlefield medicine, the homefront scientists were contributing enormously to a body of knowledge that would become essential to the restorative surgeries returning GIs would need when they returned to the States.

surgeons were assigned. Though the intentions of these doctors were admirable, several critical errors resulted in a number of deaths or complications which would not likely have occurred had more specially trained personnel been available. Significant lessons were learned from hundreds of adverse outcomes regarding amputation skin flaps, but there were even more serious errors made. A staggering number of deaths related to anesthesia during the surgeries at Pearl Harbor's medical facilities were reported immediately subsequent the attack. This resulted from the lack of knowledge of how patients in shock would respond to the Pentothal (sodium thiopentone) IV anesthesia. Anesthesiology was not, at this point in medical history, a recognized or well-regarded specialty in the United States. The fact that, at the time of the attack, the Army provided a small number of nurses a woefully inadequate three-month training program to become "anesthetists" gives evidence of the lack of awareness of the demands of this specialty. The limited cadre of trained anesthetists inside the Naval Hospital were overwhelmed by the volume of casualties. The result: scores of volunteer doctors improvised with Pentothal in order to allow surgeons to perform the necessary operations. And despite their intentions, the result was tragic. Deaths by cardiovascular collapse were the repercussion of using only intravenous Pentothal during the entire procedure. Though the exact number of deaths attributable to this cause has not been firmly calculable, this incident is still being investigated and the example is frequently taught as a cautionary tale to anesthesiology students around the world.

A WOUNDED SOLDIER'S BEST CHANCE

While Americans on the homefront prepared for involvement in the war, doctors and logistics experts were planning the best ways to deliver treatment to wounded soldiers. This quickly evolved into bringing life-saving care as close to the front lines as possible. Since the rugged terrain of the Pacific islands was very different from the cities and well-mapped countryside of Europe, American Surgeon General Percy J Carroll, knew that doctors would have to carry in what was needed to treat the wounded. Previously, the customary treatment facility was the 400-bed or 750-bed "evacuation hospital," but that was too large and impractical for most of the tiny, mountainous Pacific Islands, even though adequate medical care was as necessary to winning a battle as ammunition. Allocating a huge amount of time and resources to set up a hospital complex wasn't practical, and the swampy or jungle-covered terrain meant that a large scale on-land

medical unit simply wasn't possible. Carroll's solution was the revolutionary Portable Surgical Hospital, or PSH. The name PSH was changed late in the war to the more familiar Mobile Army Surgical Hospitals, famously known as MASH.

The portable surgical hospital was a simple, but effective and logistically flexible idea: the most urgent care would be provided immediately behind the front lines, using a few canvas tents and all necessary equipment in conjunction with the mandate that it be carried by the 29 men who would staff the unit. This strict weight limit would assure it remained truly portable, but it would also severely limit the supplies available and which surgical personnel could be



Portable Surgical Hospital in the Philippines

1943 US Army Office of Medical History

assigned to operate there. This also meant that women (ie, nurses) could not be engaged in the delivery of care in these front-line units. This was a radical departure from earlier directives regarding treating the injured. Youth, vigor and adaptability were the main considerations in deploying the PSH. The necessity of mobility would come to override the surgical experience. This upended the chain of command, yet Percy gambled that it would give wounded soldiers the best chance of survival. This policy decision also served to cement the development of the medical "technician" positions in the US Army units and on ships where women were not allowed to serve. Hence, the establishment of stateside training programs to address the demand for these occupational specialists for deployment.

A chart depicting the battle casualties of the front line list the rank of the wounded, and how to proceed with each patient's care. The "Surgical Hospital" is shown to float between the second and third echelon. The first echelon were the medical aid personnel ("medic!") at the front lines, where combat medics or Navy corpsmen run to attend to a wounded man. Second echelon is the first safe place, an aid station that is under a red cross "no fire" symbol, where medical treatment can be given. Second echelon placement is how

close to the “front” the portable surgical hospitals were most often placed - just outside the range of artillery fire.

Consideration had to be given to phasing the treatment of critical injuries. Only the most necessary surgery would be done this close to the front line, and this concept was another groundbreaking idea. Determining how to direct

Burn victims dominated the casualties during the morning of the attack. Sixty percent of the injuries were either flash burns (analogous to a bad sunburn with widespread first- and second-degree burns from exposure to extreme heat) or more severe burns from being thrown into the harbor where fuel flamed on the surface of the water.

commonly general/ thoracic/orthopedic, neurosurgical and maxillofacial) and consisted of a chief surgeon, assistant surgeon, an ‘anesthetist,’ a surgical nurse and two surgical technicians. The ASGs were assigned as a separate unit attached to a field hospital. The surgical teams stayed and operated at the field hospital under the direction of the

chief of surgery at the hospital, but were dispatched to medical clearing stations during times of heavy casualties. When out at the front lines with the troops, the ASGs reported to the commanding officer of the battalion to which they were assigned.

After doing only the most crucial procedure and stabi-

lizing a patient for transport, the goal was for the ASGs to transfer the wounded to 400-bed field hospitals. Field hospitals were technically still mobile, usually functioning inside of tents or portable buildings, but with more substantial equipment. Field hospitals and evacuation hospitals also were considerably safer because they were many miles interior from the battle zone. There, surgeons could perform functional and definitive repairs rather than focus on basic survival. Forward surgeons left extremity wounds open and usually delayed the primary closure of surgical sites, except for abdominal walls that were closed with large, looping sutures. Plaster casts were split and then taped, with a circle penciled over the fracture site. The next surgical revision was a primary consideration and a standing military order for the ASG surgeons, and this could be frustrating for them. However, the combination of quick access to surgery, wound management for infection control and phased treatment of injuries worked as designed. The Pacific ASGs were so successful that recruitment for additional teams went full steam ahead, and they played important roles in Europe after D-Day. ASG personnel also would come to be highly regarded because the doctors documented and analyzed the effectiveness of the front line procedures and how those procedures impacted the outcomes of subsequent surgeries. Their observations contributed to medical directives from the SDC that could correct harmful or ill-advised practices. The clinical observations of outcomes that the ASG teams would record proved immensely valuable to the entire medical system during, and after, the war. Dr Debakey would come to expand this concept when he returned to civilian

the care provided by the PSH meant finding the correct doctors to advise the Army.

The United States brought together some of the brightest medical minds to focus maximizing survival rates during the war and return very young men to a long, fulfilling life. The Office of the Surgeon General commissioned doctors for the Surgical Consultants Division (SCD) whose job was to recommend and develop surgical treatment policies.

The US military recruited Lt Col Michael E Debakey, MD, to lead the medical consultants. Dr Debakey and the SCD acknowledged that the PSH was a great concept, but they needed to get surgeons even closer to the front line. Noland Carter, MD, a contributing author for the US Army Office of Medical History describes the members of the SCD as “highly qualified and unusually accomplished individuals with special training and experience and eminent reputations in their individual fields of endeavors.”

These physicians recognized that the most physiologically unstable and critically wounded patients would not survive the evacuation to the field hospital or even to the PSH.

Dr Debakey and his colleagues recognized that the soldiers and sailors were a pre-screened patient pool of young, physically fit men. This group of patients, they hypothesized, would be able to survive their wounds and endure partially-completed surgeries so that they could be evacuated to a safer location for more definitive procedures. This led the SDC to propose, develop and implement the Auxiliary Surgical Group (ASG) in 1942.

The ASGs were arranged by surgical specialty (most

lizing a patient for transport, the goal was for the ASGs to transfer the wounded to 400-bed field hospitals. Field hospitals were technically still mobile, usually functioning inside of tents or portable buildings, but with more substantial equipment. Field hospitals and evacuation hospitals also were considerably safer because they were many miles interior from the battle zone. There, surgeons could perform functional and definitive repairs rather than focus on basic survival. Forward surgeons left extremity wounds open and usually delayed the primary closure of surgical sites, except for abdominal walls that were closed with large, looping sutures. Plaster casts were split and then taped, with a circle penciled over the fracture site. The next surgical revision was a primary consideration and a standing military order for the ASG surgeons, and this could be frustrating for them. However, the combination of quick access to surgery, wound management for infection control and phased treatment of injuries worked as designed. The Pacific ASGs were so successful that recruitment for additional teams went full steam ahead, and they played important roles in Europe after D-Day. ASG personnel also would come to be highly regarded because the doctors documented and analyzed the effectiveness of the front line procedures and how those procedures impacted the outcomes of subsequent surgeries. Their observations contributed to medical directives from the SDC that could correct harmful or ill-advised practices. The clinical observations of outcomes that the ASG teams would record proved immensely valuable to the entire medical system during, and after, the war. Dr Debakey would come to expand this concept when he returned to civilian

practice after the war, and this was his inspiration to overhaul the National Library of Medicine.

The ASGs, though initially controversial among the tactical and medical establishment, quickly proved how effective they were. These compact, portable clinics allowed for life-saving surgery in places and circumstances where a critically wounded soldier might not survive the long, and often dangerous, trek through jungle, mountain or swamp to get to a larger hospital. These doctors, nurses and techs were terrifyingly close to the front lines and operated in primitive conditions that stateside doctors could not have imagined, yet they contributed significantly to the overall survival rate of soldiers and sailors wounded during WWII. The concept was a game-changer, was lauded by military officers at the time and the basic model remains in use today, though dramatically enhanced by the advent of helicopters and rapid air military transport capabilities.

WAR RAGES ON

The second installment in this series will be published in June. That article will elucidate the delivery of medical service around the time of the Invasion of Normandy. As these anniversaries of major events of the WWII occur, we should all remember that so many instruments on our Mayo stands are named after distinguished surgeons who are also veterans of WWII. WWII defined the 20th century and propelled innovation in medicine and surgery. Surgical technology has its roots in WWII, and so does the entire system of surgical specialization. The opportunities to honor those who served our country and those who contributed to this history first-hand are rapidly dwindling, and I am humbled to be able to write about this subject.

ABOUT THE AUTHOR

My Neighborhood MASH

My name is Dolores Goyette, CST, DC. I am a faculty member at Mass Bay Community College in Framingham, Massachusetts. The college is only two miles from the Museum of World War II in Natick, Massachusetts. The museum has the only remaining, fully-equipped WWII-era Mobile Army Surgical Hospital (MASH) in the world. My students and I have had wonderful visits there, and I am grateful for the support of this amazing museum as an instructor and as a fledgling author.

Having a sense of pride that surgical technology as a profession has its roots in the military as specially-trained technicians who assisted the surgeons of WWII, I became very curious about the MASH. I wanted to learn more about the equipment and instruments on display and began researching what took place inside these hospital tents in the 1940s. The passage of 75 years

SNAPSHOT: LT COL MICHAEL DEBAKEY, MD



Dr Michael Debakey, right, receiving the Legion of Merit Award in 1945 from Surgeon General Norman Kirk

Department of Veterans Administration

Michael Ellis Debakey, MD, is one of medicine's most recognized names. During his lifetime, he became one of the most influential members of military medical systems, a surgical

trailblazer, prolific researcher and an international healthcare ambassador.

Dr Debakey served his country in World War II as chief of the surgical consultants division, remained in the military for a year after the war to establish follow-up care for returning soldiers. When he returned to civilian practice, he continued to work tirelessly for veteran's medical care systems. Dr Debakey created research libraries and systems through which the powers of national governments could influence healthcare policy.

Research that was available from treating the thousands of veterans would propel Dr Debakey's work with the National Research Council and inspire him to push the boundaries of surgical procedural methods. His work as a pioneer of cardiovascular surgery would make him one of the best-known doctors in the world, and he was chosen as the personal physician to some of the world's most powerful leaders and famous faces. Dr Debakey received numerous awards and acclamations, and was featured on the cover of Time magazine in 1965 for his work on the development of the artificial heart. Despite his broad success, he continued to perform surgery, teach and conduct research until the age of 90. He was 99 years old when he died.

An innovator since his youth, the simple, eponymous forceps and clamp are only two of the 50 surgical instruments or methods he invented. The basis for the heart/lung bypass machine, the Dacron arterial graft and the arterial endarectomy are among his accomplishments.



Dolores Goyette, shown in the red shirt, is pictured with her surg tech students and faculty from Mass Bay Community College

Photo courtesy of Dolores Goyette



MASH tent on display in Natick, MA September 2016

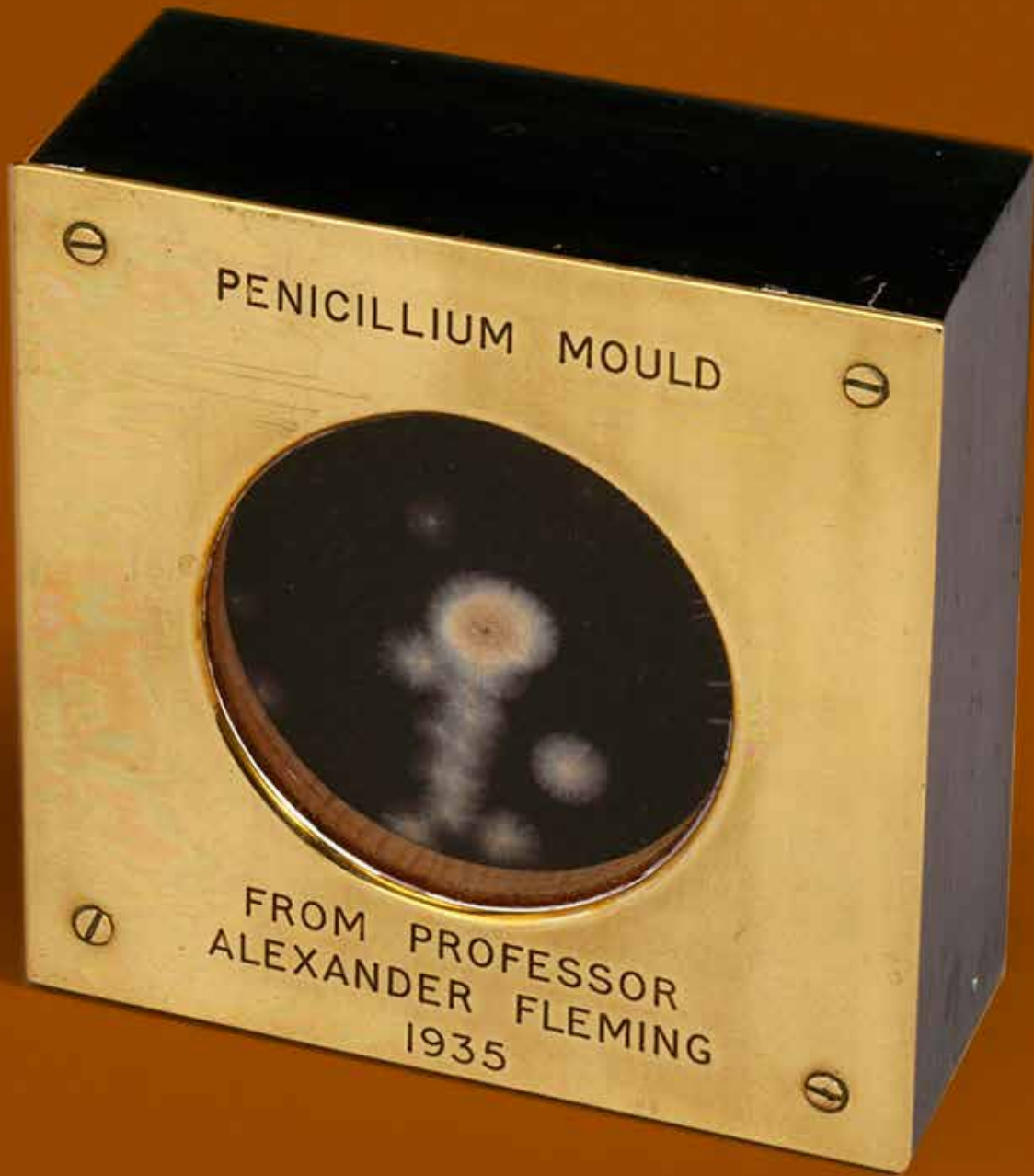
Dolores Goyette

was represented by familiar Cushing forceps, Kelly clamps and a Balfour retractor, yet there stood a rudimentary anesthesia machine and terrifyingly inadequate sterilizer. The life-saving work that was done in these conditions left me awestruck.

My initial intention was to write a single technical article about how much surgery had advanced since the war. No matter how hard I tried, I couldn't just write a technical article. My thoughts remain fixed on the people who would have been inside that MASH. I felt compelled to give my best effort at telling some of their amazing stories, and I am grateful for the opportunity to do that.

REFERENCES

1. Beecher, H. Anesthesia for Men Wounded in Battle, chapter III. US Army Medical Department, Office of Medical History. Accessed October 2016. <http://history.amedd.army.mil/booksdocs/wwii/surgeryinwwii/chapter3.htm>
2. Bennetts, FE. Thiopentone anaesthesia at Pearl Harbor. *Br J Anaesth.* (1995) 75 (3): 366-368. doi: 10.1093/bja/75.3.366
3. Carter, BN. Surgical Consultants in the Zone of Inferior. US Army Medical Department, Office of Medical History. Accessed October 2016. <http://history.amedd.army.mil/booksdocs/wwii/actvsurgconvoli/CH01.htm>
4. Condon-Rall, ME; Cowdrey, AE. Medical Service in the War Against Japan. 2015.
5. Crowhurst, J. The Legacy of the Anaesthesia 'Events' at Pearl Harbor, 7th December 1941. 2014 Jul;42:21-4. <http://jmvh.org/article/the-legacy-of-the-anaesthesia-events-at-pearl-harbor-7th-december-1941/>
6. Diamond, Jon. World War 2 Casualties & Caring for the Wounded. 2015. Accessed October 2016. <http://warfarehistorynetwork.com/daily/wwii/world-war-2-casualties-caring-for-the-wounded/>
7. Enlisted Technicians – Chapter VII. US Army Medical Department Office of Medical History. Accessed October 2016. <http://history.amedd.army.mil/booksdocs/wwii/medtrain/ch7.htm>
8. Griffith, H. Johnson, Enid. The Use of Curare in General Anesthesia. *Anesthesiol.* 1942;3(4):418-420.
9. Lord, W. Day of Infamy, 60th anniversary. Holt. 2001.
10. The Michael E DeBaakey Papers. US National Library of Medicine. Accessed October 2016. <https://profiles.nlm.nih.gov/ps/retrieve/Narrative/FJ/p-nid/329>
11. Pearl Harbor Navy Medical Activities, Navy Medical Department Preparedness, 1941. Naval History and Heritage Command. April 2015. Accessed October 2016. <https://www.history.navy.mil/research/library/online-reading-room/title-list-alphabetically/p/pearl-harbor-navy-medical-activities.html>
12. Procurement, 1941-1945: Medical, Dental, and Veterinary Corps. US Army Medical Department, Office of Medical History. Accessed October 2016. <http://history.amedd.army.mil/booksdocs/wwii/personnel/chapter6.htm>



Sample of penicillin mould presented by Alexander Fleming to Douglas Macleod, 1935.

The Surgical Legacy of World War II

Part 2: The Age of Antibiotics

DOLORES GOYETTE, CST, DC

Author's Note: As our nation remembered the 75th anniversary of the battles of World War II back in December, we also should acknowledge the contributions of outstanding medical personnel – whose incredible vision, intensive planning and heroic efforts gave the wounded an extraordinary chance of survival. Among them are distinguished military surgeons, whose experiences inspired them to invent and implement methods and instruments we know the names of, because they are used every day in modern ORs. Yet there are countless names not mentioned here – men and women of all races, ranks and occupations, whose contributions are no less important to the effort to mitigate human suffering and who are profoundly worthy of being remembered. Why should we, as working CSTs, care about this increasingly distant history? Because the surgical technology profession can trace its inception to this period in American history – as the military planned for, and then entered – the first truly global conflict.

This series of articles provides an overview of the key surgical developments of World War II. The story began with “Part 1: Pearl Harbor, Preparation and Portability,” which was published in the December 2016 issue of The Surgical Technologist. Part 1 discussed the tactical and medical planning and build-up prior to America’s formal entry into the war following the attack on Pearl Harbor on December 7, 1941. That article

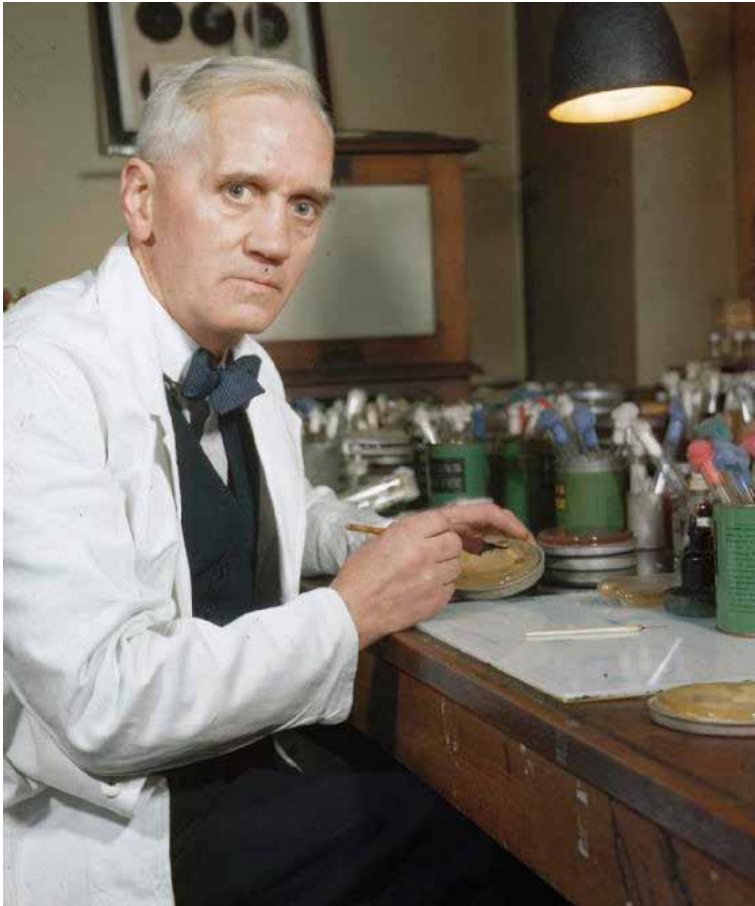


Soldiers of the 16th Infantry Regiment, wounded while storming Omaha Beach, wait by the chalk cliffs for evacuation to a field hospital for treatment, D-Day, June 6, 1944

Photo credit: US Army

LEARNING OBJECTIVES

- ▲ Learn about the scientists who discovered penicillin
- ▲ Recall when the drug first reached troops serving on the frontlines
- ▲ Evaluate how companies with fermentation expertise became critical to the process of creating the “miracle cure”
- ▲ Review what fruit became the saving grace in the road to producing penicillin to the masses
- ▲ Discuss how penicillin would come to alter decades of healthcare worldwide



Sir Alexander Fleming, who first discovered the mold *penicillium notatum*, is shown at his laboratory at St Mary's, Paddington, London. He was awarded the Nobel Prize in Physiology or Medicine in 1945 with Howard Florey and Ernst Chain.

Photo credit: Imperial War Museum

also summarized the logistical reality of delivering surgical care on the islands of the Pacific and the disparate terrain encountered around the Empire of Japan.

In this article, part 2, the focus will be on the development of penicillin and how the medical history of WWII would be remiss without it. The first use of penicillin occurred in 1942 as a direct result of the war effort in the US and Britain. Penicillin was immediately recognized for its value to society. By 1945, the scientific team that discovered and brought it to market were knighted in England and given the Noble Prize in Physiology or Medicine. To put this in context: this Nobel Prize was awarded less than six years after the discovery of medical dose capable penicillin. The discoverers of DNA waited almost 12 years before they received theirs. Penicillin is still widely touted as one of 20th century's most enduring breakthroughs, and its discovery has forever changed infection control in surgical practice.

THE WAR ON INFECTION

Infection and disease are historically greater causes of death among both military and civilian populations during war time than direct combat injuries. Early in WWII, both troops and civilian casualties were facing infections at an alarming rate. Pneumonia could race through barracks and ships before men ever reached the battle zone. Retained foreign bodies and dirt led to tetanus and devitalized tissue causing gangrene and septicemia. Osteomyelitis festered in compound fractures for numerous months after injury and often tragically resulted in delayed amputations – essentially the same medical response to these conditions before and during the US Civil War.

Many lessons were learned from World War I (1914-1918) and earlier conflicts regarding wound infections. The mortality rate and amputation rate for infected combat surgical sites took a staggering toll on veterans. After every conflict in our nation's history, amputees and grieving families were a part of most Americans' daily life. The impending war drove the quest for a better way to treat infection. The scientific community and fledgling pharmaceutical industry embraced the challenge as the nation prepared for the start of WWII.

When the war began, American GIs and corpsmen (precursors to CSTs in some cases) carried sulfanilamide packets and were trained to use it as a wound powder and oral tablet. It was quickly determined simply sprinkling a soil-filled gunshot wound with powder as a means of mitigating infection did not live up to expectations derived in a lab or hospital setting. The lack of available irrigation for these soiled wounds could not be curbed by the topical application of the sulfur drug. While the sulfa-based drugs reduced systemic infection to some degree when taken as a tablet, confidence in this drug therapy declined. Sulfanilamide's effectiveness was simply not greater than the risk of allergic reaction, toxicity and other serious adverse effects.

SERENDIPITY AND SCIENCE

Following WWI, Sir Alexander Fleming, a Scottish biologist, was already well known in the scientific community for identifying enzyme lysozyme (present in tears and mucous) and for naming and discovering the cause of gas gangrene, *c. perfringens*. Fleming and his British contem-



Medics attend to wounded soldiers on Utah Beach in France during the Allied Invasion of Europe on D-Day, June 6, 1944.

Photo credit: US Army



poraries relentlessly worked against the death rate caused by infection and infectious diseases. Fleming, and many others, spent so much time in hospital wards doing their research that he grew capable of determining types of infection simply from their characteristic smell. As Europe grew nervous for the impending second world war, these same bacteriologists were furiously researching infection control methods in an effort to avoid the calamity of WWI and the infected patients.

Fleming had discovered a bactericidal mold in 1928 upon his observation that a fungus in a forgotten petri dish seemed to repel a replicating *Staphylococcus* colony. Fleming immediately recognized the potential value of his discovery to the medical community. Converting a fungus into a medication, of course, is not an easy task. He and his team struggled with penicillin on two fronts: growing an adequate amount of the mold for experimentation, and determining how to identify and extract the elements of the

mold that killed the bacteria. Fleming and his early collaborators ultimately abandoned penicillin because they thought these problems were insurmountable. However, Fleming's mold discovery found fertile ground in 1938 when two scientists at Oxford read his decade-old research article. Ernst Chain and Howard Florey were inspired by the research, and thus began a mission to turn Fleming's fungus into an antibacterial medication.

Chain and Florey recruited a team of scientists to do the research and development on penicillin. The method of extraction was perfected in a single year in the primitive labs of Oxford. The development team recognized in studies of mice that parenteral administration was useless. Producing an injectable medicine was far more laborious, but ultimately successful. Urinary evidence of the drug and its desired bactericidal effect was present in the mice after injection. Research on the safety of the drug consisted of a few animal studies and a single, consenting, terminally ill

Snap Shot: The Discovery of the Placebo Effect

When medication supply ran short of the demand, medics improvised in order to relieve the suffering of the wounded soldiers. This practice did not go unnoticed. Colonel Henry K Beecher, MD, made the observation in 1943 that offering a severely wounded soldier a cigarette would reduce the amount of morphine needed to control pain. This would lead to Dr Beecher's discovery and research of the powerful placebo. The brain's ability to bypass pain pathways proved to be an act of humanity and a source of scientific inspiration. When utilizing placebos became a method to validate the action of a drug, Dr Beecher would come to question the morality of this practice and would soon be recognized as the father of medical ethics.

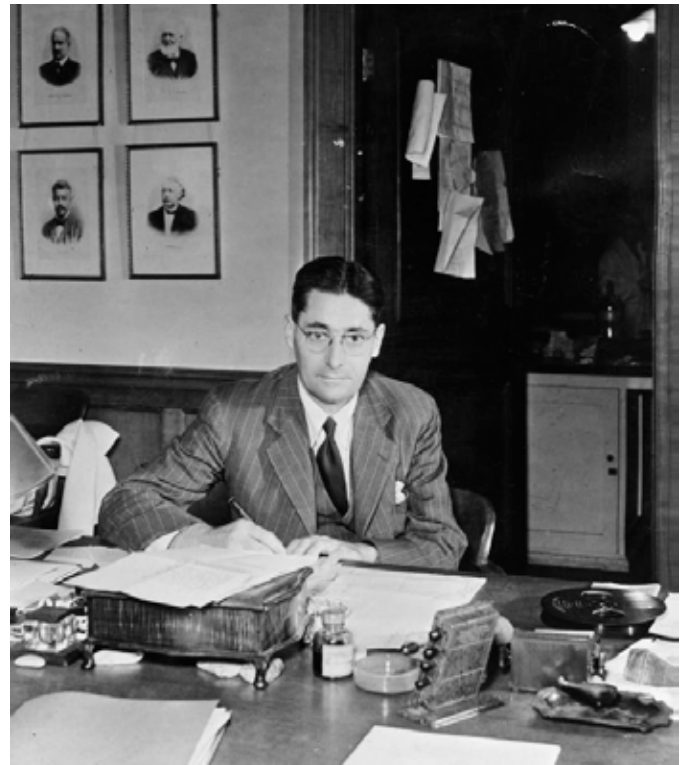
volunteer. No toxicity was observed, and the patient's blood and urine tested positive for penicillin and was found to kill bacteria. The scientists finally had the information needed to take their research efforts to the next level.

The first, true clinical trial of the therapeutic effect of penicillin occurred in London in February 1941. This second test patient had a raging staphylococcus infection on his face, one so severe that one eye had to be removed. The patient responded well and without toxic effect to the regimen of a penicillin injection given every three hours. To illustrate the challenges faced for mass producing the drug, the available supply of penicillin from the Oxford lab was not able to keep up with the amounts the trial demanded, and in fact that single patient and his infection, utilized all the available medicine. Supplies ran so low, that despite the demonstrable efficacy of this treatment, the patient died from sepsis when there were no more doses available. This challenge continued even into the beginnings of mass-production into 1942 when 50% of US supply was utilized to save a single patient.

The 1941 London trial continued slowly because of how difficult it was for the Oxford scientists to produce the penicillin. Supplies were so scarce that scientists and nurses collected the urine of the patients to study if it could be reprocessed to extract the medication. Penicillin quickly proved its effectiveness, but the Battle of Britain began to impact English manufacturing companies and their facilities, and the resources needed to develop and mass produce the drug were increasingly difficult to obtain.

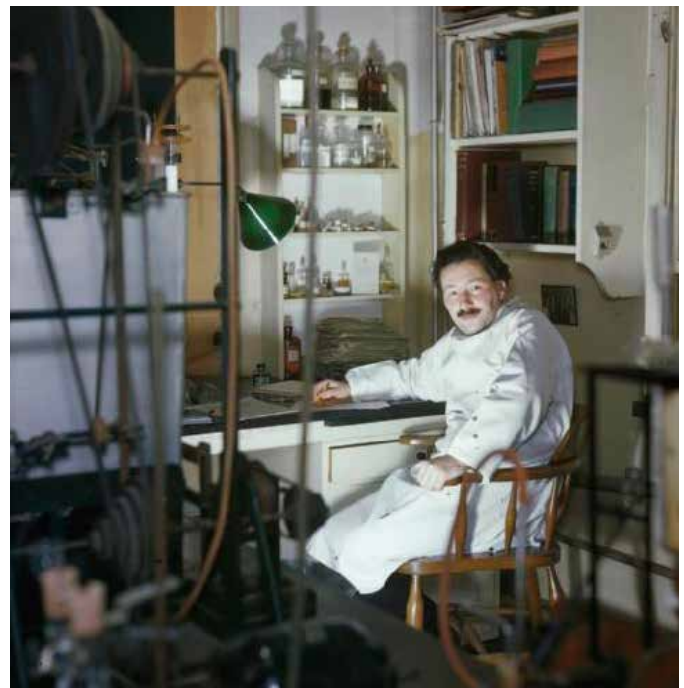
British scientists struggled greatly, as Fleming himself did, to grow the mold. Chain and Florey were desperate for help and looked to the US Department of Agriculture and a specialized research facility in Peoria, Illinois. The Peoria team was blessed with a serendipitous finding: an assistant presented the microbiologists a profusely moldy melon bought at a local market. The mold happened to be a relative of Fleming's penicillin and it possessed the same bactericidal properties as the original species.

The research and development team identified the best method for producing the finicky mold and subsequently issued a public challenge to help bring penicillin to market. Armed with ingenuity and abundant raw materials, the race to manufacture the world's "wonder drug" began. The companies with fermentation expertise, like Kentucky bourbon makers and established chemical manufacturers, quickly became the front runners in growing the finicky mold.



Professor Howard Florey makes notes as he sits at his desk at the Sir William Dunn School of Pathology in Oxford.

Photo credit: Imperial War Museum



One of the scientists involved in the search for a method of producing penicillin synthetically, Dr E B Chain of the Sir William Dunn School of Pathology at Oxford.

Photo credit: Imperial War Museum

"THANKS TO PENICILLIN, HE WILL COME HOME."

American drug manufacturers achieved remarkably quick success with the production process of penicillin. By May 1942, 400 billion units were available. Civilian use of the drug was strictly rationed so that most of this "miracle cure" could be reserved for the military. Penicillin first reached the troops in February of 1943 when the British and Americans were battling Italy and Germany in Sicily.

Production methods in late 1943 were advancing rapidly. American factories worked 24 hours a day in order to create the stockpile of penicillin that would accompany doctors during the invasion of Europe after June 6, 1944. Toward the end of the war, 21 American pharmaceutical companies were producing 650 billion units a month. The technological advances achieved during the search to increase penicillin production would catapult US pharmaceutical companies to enormous influence and success. These companies would grow to produce half of the world's pharmaceuticals by the late 1940s.

Originally, penicillin was seen by the US Army as the ideal drug to cure infectious diseases, such as venereal disease and respiratory illness. Soon, however, the effectiveness of penicillin at preventing infection was embraced wholeheartedly by the Surgical Consultants Division. Protocols for penicillin administration were determined and instructions for its use post-operatively were disseminated starting in mid-1944 until the end of the war. Penicillin is credited for saving thousands of lives at D-Day in the latter part of the war. One estimate suggests that the mortality rate was reduced 12% to 15% through the use of penicillin alone.

The Ongoing Battle Against "Superbugs"

Biologists are experts on evolution and adaptation. Alexander Fleming in his Noble Prize acceptance speech in 1945 cautioned the medical community to use penicillin judiciously to halt the impact of natural selection – the survival-of-the-fittest concept of evolution. Wide-spread, prophylactic use of penicillin and improper antibiotic use has brought the medical community into another costly war on infection with the rise of "superbugs." These resistant, adaptable bacteria are a true public health crisis for both patients and healthcare workers today. Surgical technologists are exposed to MRSA, VRE and other multiple resistant bacteria at increasing rates. Currently, research is being conducted on the necessity of routine pre-surgical antibiotics for different types of "clean" surgical cases.



A laboratory worker measures purified penicillin into ampoules or bottles in a laboratory in England in 1943. At the end of this process, a powder is left behind.

Photo credit: Richard Stone/Imperial War Museum

A laboratory worker checks on one of the 4,000 flasks containing corn steep medium and spores of penicillium mould in England in 1943.

Photo credit: Imperial War Museum



The Drug Companies of Nazi Germany

American pharmaceutical companies were full of German influence during the 1940s. German-born scientists and chemical engineers emigrated to the US after WWI and brought great advancements to the industry. The invention of numerous drugs from aspirin to meperidine (Demerol) can be credited to German intellectual prowess. Sulfanilamide, the first antibiotic used by the US in WWII, was developed in Germany in 1932.

The successful mass-production of penicillin in the US is highlighted by the fact that the Germans could not accomplish this same task. Despite the fact that IG Farben, the German government's drug manufacturing parent organization, was at its height of industrial and economic power, it could never mass-produce penicillin for its own troops. The Nazi's even attempted to steal the original mold from Fleming's British laboratory. Penicillin remained unattainable for Germany, likely due to the lack of coordination between industries and agencies that the Americans excelled at. The Germans were desperate for penicillin for all the same reasons that the Allies were. Even though IG Farben had amassed immeasurable wealth through its expertise in the mass-production of so many other things such as truck tires (a reason Germany and other nations wanted to occupy the rubber tree-growing islands of the Pacific) and vitamin tablets, penicillin frustrated them.

Still, IG Farben was a significant source of funding for Hitler's regime. When Hitler's concentration camps became a source of human research subjects, IG Farben took part in horrific experiments on prisoners. The companies also produced massive amounts of chemical weapons. When the Allies won the war, IG Farben's participation in those atrocities would lead to its executives being convicted of war crimes at the Nuremberg Trials of 1947.

The task of injecting surgical patients with penicillin fell to nurses and corpsmen (surgical technicians). The historical account of Sgt James K Sunshine, an army corpsman/surgical technician, at a Normandy field hospital just after D-Day describes the role penicillin played in post-operative infection control.

"The Ward Tent: A quiet night. Sixty men fresh out of surgery are sleeping on canvas Army cots. I have drawn ward duty, and dutifully go from cot to cot with a syringe loaded with penicillin, thrusting it quickly into each man's buttock. It's a real wakeup call, but most of them are too sick to care."

The creators of penicillin were honored internationally with lavish award ceremonies and earning their faces on stamps and coins as well as earning the Nobel Prize. Yet, it was truly a collaborative effort among British and American scientists with the sacrifices of the US civilians on the homefront that led to one of the greatest victories of WWII. The collective efforts of these two nations not only produced a single drug, but opened a new frontier in the war on infectious disease. As American GIs fought across Europe and the Pacific, a new frontier of research into infection control was opened up by scientists at home. When 1.7



Modern antibiotics are tested using a method similar to Fleming's discovery.

Photo credit: CDC

million of them returned stateside for continued medical care of their war wounds, the hospitals were safer places to rehabilitate and receive restorative surgeries.

The next article in this series will cover the trailblazing doctors who discovered the surgical techniques that would alter the course of not only the veterans' recovery, but improve the human condition around the world.



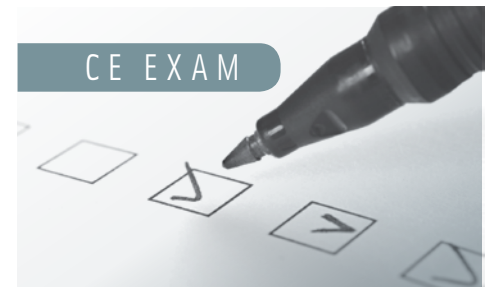
ABOUT THE AUTHOR

Dolores Goyette, CST, DC, is a member of the surgical technology faculty at Mass Bay Community College in Massachusetts, where she oversees clinical externships

in more than a dozen Boston area hospitals. The inspiration provided by stepping into some of the best hospitals in the country with her students fuels her passion for the study of surgical history, which has been driven by the military, the birthplace of the modern surgical technologist. Dolores is grateful for the support of her family and colleagues as she dedicates time to this research, and into writing this series of articles.

REFERENCES

1. Fraser, I. Penicillin: early trials in war casualties. *Br Med J (Clin Res Ed)*. 1984 Dec 22; 289(6460): 1723. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1444782/?page=3>
2. Markel H. The real story behind penicillin. September 2013. <http://www.pbs.org/newshour/rundown/the-real-story-behind-the-worlds-first-antibiotic/>
3. Penicillin Production through Deep-tank Fermentation. National Historic Chemical Landmark. New York. American Chemical Society. 2008. <https://www.acs.org/content/acs/en/education/whatischemistry/landmarks/penicillin.html>
4. Shama, G. Kulturkampf: The German Quest for Penicillin. *History Today*. March 2003;53(3). <http://www.historytoday.com/gilbert-shama/kulturkampf-german-quest-penicillin>
5. Steinert, D. The Function of a Field Hospital in the Chain of Evacuation During WWII. 2000. http://www.mtaofnj.org/content/WWII%20Combat%20Medic%20-%20Dave%20Steinert/beachhead_hospital.htm
6. The Pharmaceutical Golden Era: 1930-60. *Chemical & Engineering News*. American Chemical Society. 2005. <https://pubs.acs.org/cen/coverstory/83/8325/8325golden.html>
7. Weeden WM, McNeer G, Stein HD, Long JC. Experiences with Post-traumatic Osteomyelitis in World War II. New York. *Ann of Surg*. January 1947;89-95. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1803211/pdf/annsurg01370-0106.pdf>



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Men of the 16th Infantry Regiment, US 1st Infantry Division wade ashore on Omaha Beach on the morning of June 6, 1944.

The Surgical Legacy of World War II

Part 3: Blood and Valor

DOLORES GOYETTE, CST, DC

Author's note: As our nation remembers the 75th anniversary of D-Day and the final battles of World War II, we should acknowledge the contributions of outstanding medical personnel, whose incredible vision, intensive planning, and heroic efforts gave the wounded an extraordinary chance of survival. Among them are distinguished military surgeons, whose experiences inspired them to invent and implement methods and instruments that bear their names, because they are used every day in modern ORs. Yet, there are countless names not mentioned here—men and women of all races, ranks, and occupations, whose contributions are no less important to the effort to mitigate human suffering, and who are profoundly worthy of being remembered. Working CSTs should care about this increasingly distant history because the surgical technology profession can trace its inception to this period in American history, as the military planned for and entered the first truly global conflict.

“Blood and Valor” is third in a series of articles called *The Surgical Legacy of WWII*, written to provide an overview of the key surgical developments of World War II. “Part 1: Pearl Harbor, Preparation and Portability,” published in the December 2016 issue of *The Surgical Technologist*, discussed the tactical and medical planning prior to America’s formal entry into the war following the attack on Pearl Harbor, as well as the logistical reality of delivering surgical care on the islands of the Pacific and the disparate terrain encountered around the Empire of Japan. “Part 2: The Age of Antibiotics,” published in the June 2017 issue, focused on the development of penicillin and the advent of perioperative antibiotic therapy.

The Invasion of Normandy, which began on D-Day, has been memorialized in popular books, films, and television series, holding the attention of historians for 75 years. The magnitude of planning and collaboration required is juxtaposed against the haunting personal accounts that have made their way home to be told to future generations. The Invasion of Normandy was, and remains, the largest amphibious assault ever conducted. The attack on the German defenses along the northern coast of France, with five separate beaches assaulted simultaneously represented the Allied effort to free Europe from Hitler’s terror. More than 160,000 Allied troops crossed the beaches into France in 12 hours that first day, and another 13,000 American paratroopers dropped behind enemy lines via parachute and gliders.

The improbable success that the Allied forces were able to achieve in

LEARNING OBJECTIVES

- ▲ Learn about the Invasion of Normandy, which began D-Day in June 1944
- ▲ Examine how many medical personnel were pulled from the healthcare system to serve the soldiers on the frontlines
- ▲ Read about the key personnel who made a difference during and after the world wars
- ▲ Identify the role surgical personnel played in establishing a care system during the war
- ▲ Recall the conditions the surgical field teams had to deal with to administer care to the wounded

spite of the countless calamitous events on that day could have easily turned to further tragedy and changed the outcome of history. The military strategy for D-Day is a well-documented and fascinating topic. However, of particular interest to readers here should be the stunning volume of medical preparations, and the enormous sacrifice and bravery of the military surgical teams leading up to, during, and following the Invasion of Normandy in early June 1944.

The harsh realities of war were inescapable in every corner of the globe between 1941 and D-Day. The Allied forces

The recruitment of medical personnel between 1942 and 1944 was as significant to the war effort as manufacturing. Doctors and nurses represented an invaluable human resource, and their skills were desperately needed to care for gravely injured patients, many of whom were mere teenagers. Medical college students felt the same call of duty that so many other Americans did at the time, but the armed services still struggled to meet the quotas for trained doctors. Local draft boards were reluctant to enlist doctors and remove them from their communities, and female physicians



Soldiers in cargo vehicles move onto a beach in Normandy on D-Day.

Photo credit: US Military



Gliders fly supplies to soldiers fighting on Utah Beach in France.

were engaged in warfare on several fronts. Though the United States was spared from battling on its own soil, American troops were sent to fight in Africa, Asia and the Pacific, and Europe to protect and liberate people from countries that many families had never heard of. American doctors and nurses were dispatched alongside them. The US Military sent 16,353,639 men and women into service. While over 407,000 were killed, medical personnel — the brave men and women risking their lives to save others’ — would send home more than 671,000 wounded Americans to heal from the visible and invisible scars of war.

*“One who wishes to be a surgeon first must go to war.”
-Hippocrates*

training at medical colleges for women were ineligible to serve in the Medical Department. By 1944, there were 52,000 physicians in the Army and Navy, while 94,000 remained in the civilian healthcare system stateside.

Ultimately, the American Medical Association, the Surgeon General, and the War Department worked together to create the Medical Department of the War, to begin “procuring and assigning” medical personnel to military duties that fit their training. The Medical Department exerted immense pressure to abbreviate medical and surgical internships and residencies, condensing a traditional five- to six-year surgical residency into only 27 months.

One account by surgeon Francis Moore, MD, in November 1943 at Massachusetts General Hospital in Boston describes the Army and Navy's appetite for surgeons as "insatiable." The doctors who were not able to serve were key partners with the War Department. Dr. Moore and others put their own careers on hold, making sacrifices to train young surgeons in battlefield techniques, which were often at odds with the groundbreaking surgical research being done at fine institutions around the US. (Dr. Moore eventually would collaborate with Joseph Murray Boston, a WW2 veteran and Nobel prize-winning surgeon, on the first kidney transplant in 1954.)



Photo credit: US Military

While the Medical Department of the War was recruiting doctors, the Army and Navy's technical schools for the enlisted were quickly filling up with multi-talented, patriotic men who enlisted to serve their country. These men, and eventually women, were trained as nurses, "operating room techs," and other medical assistants and went off to war alongside the newly commissioned commanding officers: the surgeons. Individual surgical "units" were based around one surgeon as the commanding officer, but the rest of team comprised of four enlisted OR techs, usually at the rank of sergeant. The breadth of life experience and practical skills that an enlisted man who came through an Army or Navy operating room technician training program was invaluable in the lead-up to D-Day.

The composition of a "model" surgical team was described at the time as "a mature general surgeon whose primary interest is abdominal work, a general surgeon whose primary interest is chest work, a younger man with a sound surgical background. If his hospital training has been in orthopedics, so much the better. There is no need for an orthopedic surgeon in the civilian sense of the word. An anesthetist who masters the intricacies of general anesthesia in all its varieties. Four enlisted men with clear heads and steady hands." As the war raged on, the ideal surgical team became harder to realize in practice. As a result, the role of techs and nurses expanded, and the contribution these seasoned men and women made to the successful operations in these small groups is well documented.

(NOT!) FOLLOWING DOCTORS' ORDERS

The abbreviated surgical residency that some young doctors received prior to entering the European Theatre of Operations was perfectly acceptable to the career military within the Auxiliary Surgical Groups, but perhaps not as much to the fully-trained, newly commissioned medical officers in the units. Some surgeons commissioned for D-Day were of the caliber of Lt. Col. Dwight Harken, known as the father of cardiac surgery, who could successfully remove shrapnel from the hearts and great vessels of the wounded. In contrast, others were essentially third-year residents.

The Office of Surgical Consultants (OSC) issued regular directives to medical personnel regarding updates in outcomes and current issues regarding the care being given to the wounded soldiers. "Meatball" surgery, a term made famous in the memoir of Capt. Richard Hornberger and later in the TV series "M.A.S.H.", may have been quick and efficient, but it was an insult to an established surgeon with training and skill. Dr. Michael DeBakey would later state, "The best thing that can be done is not always the best thing to do."

The disobedience to the directives of the OSC was widely known, within the units and throughout the medical command structure of the Army. It was the topic of numerous communications with OSC members, and the report of the Activities of the Surgical Consultants in 1962 stated, "The fact must be emphasized that there was a wide variation in the professional abilities of medical officers. In certain instances, the application in the Army of certain surgical procedures, therapeutic measures, or drugs used in civil practice had to be prohibited. This was necessary in order to minimize undesirable results or untoward accidents known to occur when all medical officers were permitted to use the particular procedures, methods, or drugs in question."

Some medical directives affected the standard of care for POWs and wounded civilians. When the 5th ASG encountered wounded retreating soldiers and civilians, they were uncertain of their orders regarding their care. Directives from the OSC stated they were to receive the same treatment as Americans.

THE FIRST FEMALE MILITARY DOCTORS



Photo credit: US Military

Mary Edwards Walker, MD, is the only woman to receive the Medal of Honor. Walker, who graduated from Syracuse Medical College in 1855, initially volunteered with the Union Army during the Civil War as a nurse before she served as the surgeon she was trained to be. Her medal was contested and rescinded in 1917 when the standard for receiving it was revised to be limited to direct combat, but was reinstated posthu-

mously for her "distinguished gallantry, self-sacrifice, patriotism, dedication, and unflinching loyalty to her country, despite the apparent discrimination because of her sex."

The first female medical officer commissioned in the WWII was a Johns Hopkins-trained surgeon, Dr. Margaret Craighill. President Franklin D. Roosevelt signed legislation to allow women to enter the Army and Navy Medical Corps. The women served mostly in the newly established Women's Army Corps (WACS), and Dr. Craighill was commissioned as an Army major. She traveled to all theaters of operation to report on the duties, mission and health condition of 160,000 WACS nurses. A tireless advocate for women in the military, Dr. Craighill consulted extensively for the VA healthcare system after the war regarding the needs of the women veterans in their system.



Photo credit: US Military

BLOOD RED WAVES UPON THE SAND

Simulation training drills and final medical preparations for D-Day were carried out all over joint military bases on the shores of the English Channel in the late spring of 1944. The Medical Corps speculated that as many as 22,500 servicemen would be wounded on the beaches in the first few days before medical support personnel and their equipment could safely reach the theatre. In actuality, casualties among Allied forces on D-Day numbered 10,000 wounded and 4,414 confirmed deaths.

The Allied advance did not occur as rapidly as had been planned. It was six days before the beach heads were joined from the five of the landing beaches. In terms of medical services, it would be D-Day +5 before the 128th Evac hospital, set up six miles inland, would be able to treat its first patients. Infantry unit medics with basic tourniquets and morphine ampules would be the only on-scene treatment available to the wounded in the first few waves of men fighting their way across the Normandy beaches. Transporting the doctors, their medical teams, and all of their equipment to the battle zone in relative safety as soon as possible was an overriding concern for commanding officers in all phases of planning. The casualty count was a grimly unavoidable concern.

D-Day began on June 6, 1944, and it took two weeks for the invasion to achieve its stated initial goals of crossing the beaches, advancing past the cliffs, re-taking a number of key villages, and creating a unified front. The importance of this day as a turning point in WWII is impossible to overstate. The risk of harm that the first waves of men would surely face was known to everyone. A total of 2,400 soldiers were killed at Omaha Beach on June 6 alone. The members of the 3rd Auxiliary Surgical Group (ASG) were attached to the 101st Airborne Division, among other front-line units, and they knew that just getting into position to treat the massive number of mangled bodies would put them close to death themselves.

On June 6, small teams from the 3rd ASG came ashore with the troops in landing craft, parachuted or flew in on plywood gliders with the Airborne, with most men crashing hard to the ground. They relied on help from the Naval hospital tent erected on the beach to treat the staggering number of the wounded, whose blood colored the sea and sand red. Medical personnel could do nothing more than control blood loss and wait for help – both military and medical. The paucity of supplies that successfully made it ashore significantly hindered the options available to the surgical teams.

The commanding officer's account of D-Day operations to the Surgeon General is a terrifying tale of fiery gliders falling from the sky, supplies lost at sea, buildings collapsing upon makeshift operating tables, and munitions exploding all around them while treating the unceasing flow of wounded. The first makeshift ORs were set up in barns nearby using whatever medical supplies they could scavenge from what survived their landing. Other small units from the 3rd ASG would arrive the next day (D-Day +1) on the Normandy beaches.

The 3rd ASG maintained meticulous records of their



Medics attend to wounded soldiers on Utah Beach in France on June 6, 1944.

Photo credit: US Military

patients and the surgeries they performed starting on June 6, 1944, through December 1, 1944, serving 13,162 surgical patients that entered the tent flaps of the 3rd ASG, which on D-Day +22, was given additional equipment, personnel, orders, and a new name: Mobile Army Surgical Hospital (M.A.S.H.) - the first M.A.S.H., and the group was dispatched deeper into in France.

The 4th ASG arrived on the shore of France on D-Day

THE BLOOD PROGRAM OF WWII

The US Army Blood Program began in 1940, and by 1941 dried plasma was deemed safe for use. Because plasma in this form has a long shelf life, is lightweight and does not have to be type-specific, it easily could be reconstituted in remote locations where whole blood was not available. It was a major breakthrough in the treatment options for shock. By the time the US landed in Normandy, the US Army Blood Program and civilian pharmaceutical companies had collaborated to invent novel methods for banking whole blood, and for preserving, shipping, and administering other blood products and blood substitutes. There is a version of this program still in operation to support servicemen and women deployed in combat theaters.

"In World War I, men died without surgery because the means of resuscitation were not available. In World War II, men survived because they were operated on, but the fundamental reason for their survival was that they lived or, more correctly, were kept alive until they were fit to be operated on. They were kept alive by plasma until they could be given whole blood. They were resuscitated – which means, literally, brought back to life – by whole blood, which made operation possible. Very often they were kept alive during operation by the continued use of whole blood. Finally, many times, their recovery after operation was expedited by the use of whole blood, even if it was not again necessary to keep them alive." – Brigadier General Douglas B. Kendrick, Jr., 1962



Soldiers move onto Omaha Beach during the Allied Invasion of Europe on D-Day.

Photo credit: US Military

+2, following the first waves of the landings, and the physical and emotional stress on the members of the 4th ASG was recorded in letters sent home by surgeons and enlisted men alike. In a letter written to his wife on June 15, 1944, Dr. Henry K. Swan said:

“It was a hot spot then, as we are only about 1/2 mile from the flank. The details I’ll tell you some day, but

4th ASG, he treated 1,400 non-transportable patients with penetrating wounds, all of those were adjacent to the front lines. (These patients’ wounds were so severe and their condition so unstable, they would not have survived the journey to better-equipped, safer hospitals.) Dr. Swan quickly rose through the ranks to become chief surgeon of the 5th ASG.

all I know is that I never want to look up from the operating table again and see a neat little row of holes appear in the tent! The first morning, we hit the dirt in the O.R. when they came over, but when I saw the patient lying on the table with his hands over his face just sweating it out, I resolved that never again would I duck and leave the patient with the feeling of helplessness and desertion. Nor have I since.”

Dr. Swan was a vascular surgery pioneer and prominent pediatric cardiac surgeon from Boston. During his time with the

SNAP SHOT: DISCOVERY OF THE PLACEBO EFFECT

Col. Henry Knowles Beecher, MD, was an anesthesiologist in the US Army Medical Corps in Italy in 1944. During the US evacuation at Anzio the medics were running out of morphine and had to improvise a solution to the shortage. Dr. Beecher noticed that the medics could successfully reduce the necessary dose of morphine by offering cigarettes to wounded Marines. Smoking helped the morphine work at lower doses in many patients. This experience impacted him greatly, and it began his informal, wartime observation of pain control in the wounded and would eventually become a formative scientific body of work on the placebo effect. Dr. Beecher dedicated much of his early post-war career to the development of the double-blind, randomized research method that revolutionized the validation of drugs and procedures.

Dr. Beecher is also heralded as a great humanitarian and prolific author. He was among the first to investigate the Nazi surgical experiments in the concentration camps at Buchenwald and came to be a whistleblower and advocate for informed consent and sensible research methods. Dr. Beecher is known as the father of medical ethics, and a prestigious medical ethics award at Harvard Medical School is named after him.

When Swan and the 5th ASG were deployed in France, Germany, and then Belgium toward the end of the war in 1945, his steadfast correspondence with his wife chronicled his unrelenting weariness and the senselessness of war. Dr. Swan soon began quietly forgoing directives and expanded his repertoire of procedures. For example, he performed the world's first end-to-end arterial repair to save a soldier's

cadavers gave Russian Army sniper and surgeon Vladimir Filatov the opportunity to perfect corneal transplantation techniques. Ubiquitous OR tables full of patients with shrapnel-torn limbs gave rise to an exponential number of talented orthopedic surgeons who came back to the US skilled in German techniques such as the Kirshner fixation system. The astounding volume of vascular injuries

of battle created a tremendous wealth of experience for the trauma delivery system, cardiac, and peripheral vascular specialties. The role of women who served as nurses

The breadth of life experience and practical skills that an enlisted man who came through an Army or Navy operating room technician training program was invaluable in the lead-up to D-Day.

foot from amputation in August 1945 while in Germany. These maverick surgeries were groundbreaking, and would be the inspiration for his illustrious postwar career in cardiac surgery.

"... DEVOTION TO DUTY AND SKILL ..."
GEN. D. EISENHOWER, SCAEF, 6-6-44

The Invasion of Normandy was a turning point but did not represent the ultimate conclusion to the war in Europe. The Allied and Axis forces had not yet engaged in some of their deadliest battles in Europe. The months immediately following were almost inhumanely taxing for American medical personnel, and their expanded mission included absorbing surrendered German Army hospital patients and treating the survivors of Nazi concentration camps.

What was asked of the medical personnel between June 6, 1944, and the victory in Europe on May 8, 1945, must have been unimaginable for all sides. The profound physical and emotional toll of long days of caring for grotesquely wounded young bodies must have impacted these healers for the rest of their lives. Yet so many of these men and women returned to the US and to their respective nations and never spoke of the horror. The surgeons left "meatball" surgery back in the tents and committed themselves to a period of remarkable clinical advancement.

The burned skin and disfigured faces of combat rapidly lead surgeons to develop advances in plastic surgery, by which reconstructive pedicle skin grafting techniques gave men a chance to re-enter society. Eye injuries and a supply of fresh

and surgical technicians would expand in the 1950s both in the military medical ranks and in the civilian healthcare and medical college systems.

The serene high bluff over the beaches of Normandy is the final resting place for 9,387 Americans killed during the early days of June 1944. The blood that turned the Channel waters crimson was not only American, though, but it was also the blood of English, Canadian, Free French, and German combatants. The tally of those killed and wounded from both the Allies and the Germans was over 425,000 during the invasion. As our nation and the world remembers the 75th anniversary of D-Day, there is much to recognize and be grateful for. The sacrifice and contribution of the men and women who served that day did not end when the sun set over the waters of a shore not our own.

AUTHOR ACKNOWLEDGEMENTS

I want to thank my family and my mentors who encourage and support me. It is a privilege to tell the stories of the veterans and home-front heroes I work with. Below is a photo of my grandmother's book from her volunteer work in Uxbridge, Massachusetts during the War.



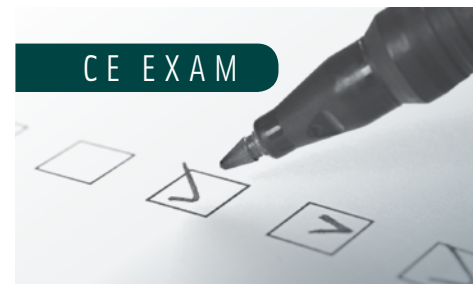


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REFERENCES

1. Barnett, Glenn. The U.S. Army Medical Corps: Caring for the Casualties in World War II. November 2019. Warfare History Network. <https://warfarehistorynetwork.com/daily/wwii/the-u-s-army-medical-corps-caring-for-the-casualties-in-world-war-ii/>
2. Debaeky ME, Simeone FA. Battle Injuries of the Arteries in World War II: An Analysis of 2,471 Cases. *Ann Surg.* 1946;123(4):534-579.
3. Friedenber, Zachary. Hospital at war: the 95th Evacuation Hospital in World War II. 2004. College Station: Texas A & M University Press.
4. Harkness, J; Lederer, S; Wikler, D. Laying ethical foundations for clinical research. *Bulletin of the World Health Organization.* 2001. 79 (4):366-372. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2566401/pdf/11368058.pdf>
5. Moore, Francis, D. A Miracle and a Privilege: Recounting a Half-Century of Surgical Advance. 1995. Joseph Henry Press.
6. Speaker, Susan. Dr. Swan Writes from Normandy, 1944. *US National Library of Medicine.* June 2014. <https://circulatingnow.nlm.nih.gov/2014/06/06/dr-swain-writes-from-normandy-1944/>
7. 3d Auxiliary Surgical Group. Unit History. WW2 US Medical Research Centre. <https://www.med-dept.com/unit-histories/3d-auxiliary-surgical-group/>
8. Activities of the Surgical Consultants, Vol. 1. Medical Department, United States Army. Surgery in World War II. Office of the Surgeon General. <https://apps.dtic.mil/dtic/tr/fulltext/u2/a286765.pdf>
9. Harvard Medical School in WWII, 1944. <http://repository.countway.harvard.edu/xmlui/handle/10473/1784?show=full>
10. Dr Margaret D Craighill. Biography. *US National Library of Medicine.* https://cfmedicine.nlm.nih.gov/physicians/biography_72.html
11. Medal of Honor Spotlight: Dr. Mary Edwards Walker. *Military.com* <https://www.military.com/history/dr-mary-edwards-walker.html>
12. Preparations for Invasion. Medical Service in the European Theater of Operations. <https://history.army.mil/html/reference/Normandy/TS/MD/MD6.htm>



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The Surgical Need— 50 Years of Surgical Technology

JAMES STEELE, CST

As AST celebrates 50 years this month, it is only natural to ponder about the history of “the tech.” How did cultures defer in how a surgery was performed or better yet, what was performed and why? Trephination was believed to be the cure all and “perhaps the first surgery to exist”;³ but historical archives show that this profession was a peppered past of magical tinctures, painful experimentation and new discoveries. Before the operating room even existed, the surgeon and the procedures he performed were seen as heroic.

Greek’s Iliad Book XI states that a surgeon “who knows how to cut out darts and relieve the smarting of wounds by soothing unguents was to armies more in value than many other heroes.”³ Gradually the operating room did come into creation, but not to what is available today. Spectacles of barbaric interest took form as the “theatre,” and held intrigued viewers that spanned professions even outside of medicine. For what was once a side job for the local barber, surgery held a more prominent intent. From inside the canvas tent of a M.A.S.H. Surgical Unit to the solid white walls of the most technologically advanced OR suite, the field of surgery has continuously maintained a common theme – the surgical need. This one short phrase has established a field that was once revered as borderline evil, to what is now seen at times as one’s only hope for survival. Amongst the members of almost any surgical suite, the surgical technologist’s beginnings parallel much of the same traits. This profession was established during

LEARNING OBJECTIVES

- ▲ Examine the last 50 years of the surgical technology profession
- ▲ Recall why the role of the scrub tech was created
- ▲ List some of the major advancements in surgery over the years
- ▲ Learn about when surgical robots were introduced
- ▲ Reflect on the scrub tech’s past and where it’s headed in the future



1990 - Antibiotic Irrigation Laparotomy

a critical time in the history of surgery and even more so, the fate of our country.

As the operating room has grown, so has the definition of not only who but what the surgical technologist has become. During the World Wars, the role of the “scrub” began in the battlefield hospitals and Navy ships that defended our freedom. “In World War I and World War II, the U.S. Army used ‘medics’ to work under the direct supervision of the surgeon. Concurrently, medical ‘corpsman’ were used in the United States Navy aboard combat ships. Nurses were not allowed aboard combat ships at the time. This led to a new profession within the military called operating room technicians (ORTs).”²² It was the trials of war that set the ground work to give surgical technology its start. It was a gritty, daring risk to continue the surgical needs of a nation. In 1969, the Association of Surgical Technologists was established by members of the American College of Surgeons (ACS), the American Hospital Association (AHA), and the Association

of peri-Operative Registered Nurses (AORN).¹ This critical and longstanding establishment was the foundation that carried the torch and was a daring breakaway from the shadows of the profession’s nursing counterparts. The surgical way of doing things has always been to ask the difficult questions and be just curious enough to try. Such can be said as the need for improvement in organ transplant increased and in 1975, a milestone set, the first laparoscopic-assisted organ transplant took place. It was a surgical need sought after to prove that shorter incisions and the creation of minimally invasive surgery even though intricate in nature were beneficial when considering the long-term outcome for the patient.

From the beginning of 1980 to the end of the 1990s, the operating room shed its “old-school” mentality and took a step into the technological age. Computers and the thought of EMR or Electronic Medical Records began to make paper records a thing of the past. Incisions became smaller as new skills in minimally invasive procedures became the new standard. A line in the

sand was beginning to appear between staff that believed in tried and true methods of old and the doctors, nurses and surgical technologists that knew that innovative treatments and procedures were a daring new chapter. As well, surgery became recognized as not only a need but sometimes as a want. In proving this point, Business Insider⁵ when referring to the evolution of the last 100 years of surgery states that “With minimally-invasive techniques on the rise, surgery entered the mainstream. The late 1970s and early 1980s saw a booming interest in plastic surgery, as people realized operations could be a form of recreation, not just life-preservation. Breast implants among other body enhancements such as the rise of total joint procedures suddenly made surgery a profitable industry. Instrumentation began to change its appearance from the archaic and sometimes barbaric tools you’d find in dungeons to more delicate and even more microscopic tools meant to advance patient care.

Even though theatre-style operating rooms were a thing

of the past, it wasn't until now that cloth gowns and reusable drapes began to make way for disposable single use products. Infection and improved practices justified the need to change for the betterment of patient care, a continuing and common matter. Then in the late 1980s, a camera was manufactured to attach to the laparoscope, giving the surgical suite an unprecedented look into the human body. Surgical technologists quickly recognized the evolution of computer driven technology and implemented an understanding and appreciation into this part of the profession into curriculum at schools around the nation. In their day-to-day operations, techs continued to push the veins of professional possibilities. Past OR doors and into "back 40" hallways or sterile processing departments, the surgical technologist started to step into administrative rolls as supervisors, managers and coordinators of supply and instrumentation.

As the year 2000 approached, so did the rise of laparoscopic surgery. More and more Americans were experiencing obesity in numbers the country had never seen before.⁵ And more and more patients were used weight-loss surgery as a way to remain healthy.

Then in 2000, the Da Vinci robotic surgical system won



1995 - Oblique osteotomy for shortening of the ulna

From the beginning of 1980 to the end of the 1990s, the operating room shed its "old-school" mentality and took a step into the technological age. Computers and the thought of EMR or Electronic Medical Records began to make paper records a thing of the past. Incisions became smaller as new skills in minimally invasive procedures became the new standard.

the US Food and Drug Administration's approval. The system is now used in a wide variety of procedures, including prostate surgeries and coronary artery bypass,⁶ was a wrist-manipulated robotic system that emphasized minimally invasive surgery.

Around the same time, the profession of surgical technology began tightening its own regulations and how the advancement into the field was conducted. For a time, on-the-job training or OJT was an easy entry into the world of surgical medicine. Facilities around the country were allowing undertrained and little scrutinized personnel to don a gown and gloves and pass the scalpel. Throughout the 2000s, AST helped to establish legislature to help standardize training, thus strengthening the validity of the surgical technologist. The millennium was a blend of the unknown as clocks threatened to end the world and excitement as that assumption proved false. The OR faced similar challenges; both positive and difficult alike.

While the regulations of the ST profession carried on, advanced minimally invasive procedures and an increased use of laparoscopy, joint replacement and heart valve transplants invited the OR team to think outside the walls of the surgical suite and ask themselves what

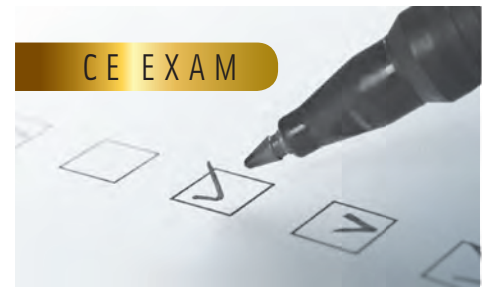
was next. For a select few, it was surgery ala telecommunication. In 2001, the first telecommunicated laparoscopic surgery between patient and surgeon (New York to France) was performed, and in 2015, the world's first successful face transplant was performed as more than 100 people worked for 26 hours to give the patient a true medical miracle.⁵

More recently a focus in the field has been on 3D imaging, printing and recreating the anatomy of those that need it. How can it be implemented with the computer more into the day-to-day practice, reduce surgical site infections and increase patient outcomes? Augmented reality (AR) also has the potential to be the new normal allowing surgeons to detail the surgeries in ways that was never possible before with computer-based simulations. (JAMA) While it's still in the process of evaluation, it's possible that AR and VR (virtual reality) will not only make surgery safer, but allow for quicker turnover time and less recovery time for the patients.⁴ Surgeon Atul Gawande² once wrote, "Prognostication is a hazardous enterprise. But if the past quarter century has brought minimally invasive procedures, the next may bring the elimination of invasion."

The role of surgical technologist began as a hope for survival, fraught from war to handle the stressors of OR life. Many of the advancements in preservation, blood management and trauma began much the same way. If it weren't for war, the practice of saving an artery, a nerve or an extremity all together may not be what it is today.

REFERENCES

1. Association of Surgical Technologists. www.ast.org/AboutUs/About_AST/
2. Gawande, Atul. Two Hundred Years of Surgery. *New England Journal of Medicine*. www.nejm.org/doi/full/10.1056/nejmra1202392.
3. History of the Operating Room. Optimus Integrated Surgical Environment. www.optimusise.com/historical/history-of-the-operating-room/
4. Murthi, S; Varshney, A. How Augmented Reality Will Make Surgery Safer. *Harvard Business Review*. March 2018. Accessed June 2019. <https://hbr.org/2018/03/how-augmented-reality-will-make-surgery-safer>
5. Weller, Chris. The Evolution of Surgery over the Last 100 Years Is Horrifying and Astounding. *Business Insider*. June 2016. www.businessinsider.com/how-surgery-has-evolved-over-the-last-100-years-2016-6#but-the-progress-also-transcended-human-surgeries-in-1996-bonah-an-18-month-old-rare-white-tiger-underwent-an-operation-to-correct-a-dislocated-kneecap-bonah-recovered-with-flying-colors-23.
6. Whitlock, Jennifer. The History of Surgery: A Timeline of Medicine. *Verywell Health*. August 2018. www.verywellhealth.com/the-history-of-surgery-timeline-3157332
7. Surgical Technologist. *Wikipedia*. April 2019. en.wikipedia.org/wiki/Surgical_technologist



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CE Exams

Orthopedic Surgery During the American Civil War

- The use of anesthetic agents in surgery was first successfully introduced in ____.**
 - Vermont
 - New Hampshire
 - Massachusetts
 - Maine
- During the Civil War, most of the Battle casualties were from ____.**
 - Gunshot wounds
 - Bayonet stokes
 - Saber stokes
 - Cannonball injuries
- How many estimated surviving soldiers were amputees following the war?**
 - 25,000
 - 35,000
 - 45,000
 - 55,000
- What was one of the three techniques used for amputations?**
 - Rounded
 - Oval
 - Inward
 - Full
- The average length of time for an amputation procedure performed during the Civil War was?**
 - 10-15 minutes
 - 15-20 minutes
 - 20-25 minutes
 - 30 minutes
- The Minié bullet, which was blamed for most of the extremity injuries introduced in ____.**
 - 1859
 - 1880
 - 1855
 - 1849
- During the first ether-induced procedure noted, which operation was performed?**
 - Abdominal dissection
 - Neck dissection
 - Arm amputation
 - Foot amputation
- Who has been credited with performing three of the four open resection internal fixation of fractured bones?**
 - Dr Henry J Bigelow
 - Dr John C Warren
 - Dr Benjamin Howard
 - Surgeon General William Hammond
- Orthopedics was officially recognized in ____.**
 - 1907
 - 1888
 - 1887
 - 1901
- What substance was used in the first noted painless procedure?**
 - Whiskey
 - Ether
 - Chloroform
 - Opium

The Surgical Legacy of World War II

Part 1: Pearl Harbor, Preparation and Portability

1. **How many American were killed during the two-hour attack on Pearl Harbor?**
 - a. 1,305
 - b. 1,803
 - c. 2,403
 - d. 2,504
2. **Burn injuries accounted for ___ of the victims of Pearl Harbor.**
 - a. 50%
 - b. 60%
 - c. 70%
 - d. 80%
3. **A large amount of deaths were related to the lack of knowledge of:**
 - a. Suturing
 - b. Trauma care
 - c. Trauma recovery
 - d. Anesthesia
4. **At the time of the attack, ‘anesthetists’ had only been trained in a ___ long program.**
 - a. Three – month
 - b. Thirteen – day
 - c. Thirty – day
 - d. Two- month
5. **The American Surgeon General at the time created what would later be known as:**
 - a. Portable Surgical Hospital
 - b. Mobile Army Surgical Hospital
 - c. Evacuation Hospital
 - d. Portable Medical Units
6. **PSHs had a strict limit of ___ men who would staff the unit to ensure they remained portable.**
 - a. 20
 - b. 29
 - c. 39
 - d. 42
7. **Lt Col Michael E Debakey, MD, helped create, develop and implement the ___.**
 - a. PSH
 - b. MASH
 - c. SCD
 - d. ASG
8. **ASGs were arranged by:**
 - a. Surgical specialty
 - b. Amount of wounded
 - c. Amount of technicians
 - d. Surgeons available
9. **Other significant injuries resulting from the attack included:**
 - a. Shrapnel wounds
 - b. Amputations
 - c. Compound fractures
 - d. All of the above
10. **___ was a great challenge to the nature of when the attack occurred and the extent of the burn injuries.**
 - a. Treatment
 - b. Recovery
 - c. Identification
 - d. None of the above

The Surgical Legacy of World War II

Part 2: The Age of Antibiotics

- In what year did the troops first receive penicillin?**
 - 1941
 - 1942
 - 1943
 - 1944
- Sir Alexander Fleming first discovered a bactericidal mold in ___?**
 - 1920
 - 1921
 - 1938
 - 1928
- The first antibiotic used by the US in WWII, sulfanilamide, was developed in:**
 - Australia
 - Britain
 - US
 - Germany
- Ernst Chain and Howard Florey, inspired by Fleming's research, started a mission to turn fungus into medication in ____.**
 - 1928
 - 1938
 - 1941
 - 1944
- In 1942, ___ of the US supply of penicillin was used to save one patient.**
 - 30%
 - 45%
 - 50%
 - 65%
- An estimate suggests that mortality rate at the time of WWII was reduced by ___ due to the role penicillin played.**
 - 10 -1 2%
 - 12 – 14%
 - 12 – 15%
 - 10 -15%
- In 1943, Colonel Henry K Beecher, MD, discovered that (a) ___ would help reduce the amount of morphine needed for a wounded soldier.**
 - Penicillin
 - Tourniquet
 - Alcohol
 - Cigarette
- The scientific team of Fleming, Chain and Florey was knighted and awarded the Nobel Prize in ____?**
 - 1942
 - 1945
 - 1950
 - 1947
- What fruit was discovered to possess the mold relative to Fleming's penicillin?**
 - Melon
 - Apples
 - Cantaloupe
 - Pineapple
- In ____, Fleming cautioned the medical community to use penicillin judiciously to halt the impact of natural selection, an effect society is seeing in the rise of "superbugs".**
 - 1941
 - 1945
 - 1947
 - 1949

The Surgical Legacy of World War II

Part 3: Blood and Valor

- 1. How many wounded Americans were sent home to heal from the scar of war?**
 - a. 407,000
 - b. 671,000
 - c. 822,000
 - d. More than a million
- 2. The only woman to ever receive the Medal of Honor is?**
 - a. Dr Margaret Craighill
 - b. Dr Mary Edwards Walker
 - c. Dr Molly Eisenhower
 - d. Dr Kendrick Edwards
- 3. On June 6, the first day of the invasion, a total of ___ soldiers were killed at Omaha Beach.**
 - a. 1,400
 - b. 1,800
 - c. 2,400
 - d. 3,000
- 4. How long did it take for the troops to achieve the initial stated goal of the invasion?**
 - a. Three days
 - b. One week
 - c. Two weeks
 - d. One month
- 5. The 128th Evac hospital was how many miles inland?**
 - a. A half mile
 - b. Three miles
 - c. Five miles
 - d. Six miles
- 6. From June 6, 1944, to December 1, 1944, the 3rd ASG served how many surgical patients?**
 - a. 13,162
 - b. 15,621
 - c. 17,443
 - d. More than 20,000
- 7. The first makeshift ORs were set up in ____.**
 - a. Shacks
 - b. Barns
 - c. Caves
 - d. Tents
- 8. Dried plasma, that was deemed safe to use in 1941, was used ____.**
 - a. To keep soldiers alive.
 - b. Before whole blood could be administered.
 - c. Both a and b
 - d. Neither a and b
- 9. It was determined that by giving the wounded ____, medics could successfully reduce the doses of morphine needed to treat patients.**
 - a. Placebo pills
 - b. Cigarettes
 - c. Water
 - d. Penicillin
- 10. The Medical Department of War abbreviated the surgical internships and residencies from five-to six-years surgical residencies to ____.**
 - a. 16 months
 - b. 20 months
 - c. 24 months
 - d. 27 months

The Surgical Need – 50 Years of Surgical Technology

1. **What year was AST (then AORT) formed?**
 - a. 1959
 - b. 1969
 - c. 1979
 - d. 1989
2. **When was the first laparoscopic-assisted organ transplant?**
 - a. 1969
 - b. 1971
 - c. 1975
 - d. 1979
3. **The role of the scrub began:**
 - a. On US grounds
 - b. On battlefields
 - c. On Navy ships
 - d. Both b and c
4. **A camera was manufactured to attach to the laparoscope in the:**
 - a. 1960s
 - b. 1970s
 - c. 1980s
 - d. 1990s
5. **In what year did the Da Vinci Robotic surgical system win the US Food and Drug Administration's approval:**
 - a. 1991
 - b. 2000
 - c. 2001
 - d. 2010
6. **The world's first successful face transplant was performed in:**
 - a. 2010
 - b. 2015
 - c. 2019
 - d. Still hasn't been accomplished
7. **Referencing the previous question, how many people did it take to perform that procedure?**
 - a. 50
 - b. 75
 - c. 100
 - d. More than 100
8. **Telecommunication surgery became an event when a laparoscopic surgery between patient and surgeon happened in what year?**
 - a. 1980
 - b. 1998
 - c. 2001
 - d. 2010
9. **What type of program will allow surgeons to see details in ways they never have before?**
 - a. X-rays
 - b. Computer imaging
 - c. Augmented reality
 - d. All of the above
10. **How many years did AST celebrate in July 2019?**
 - a. 10
 - b. 100
 - c. 150
 - d. 50

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Orthopedic Surgery During the American Civil War

a	b	c	d	a	b	c	d		
1.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	7.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Mark one box next to each number. Only one correct or best answer will be selected for each question.
2.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	8.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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The Surgical Legacy of World War II – Part 1: Pearl Harbor, Preparation and Portability

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The Surgical Legacy of World War II – Part 2: The Age of Antibiotics

a	b	c	d	a	b	c	d		
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The Surgical Legacy of World War II – Part 3: Blood and Valor

a	b	c	d	a	b	c	d	
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5.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					
6.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					

The Surgical Need – 50 Years of Surgical Technology

a	b	c	d	a	b	c	d	
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4.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	10.	<input type="checkbox"/>	<input type="checkbox"/>	
5.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					
6.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					