

# Battlefield Medicine

## Session 5

OLLI at University of Illinois  
Spring Semester 2023

# World War II

A fatalistic humorous infantry expression:

“I’m not so worried about the bullet With My Name On It , it’s the artillery Shell addressed: To Whom It May Concern that worries me!”

# World War II

February 28, 2023

Néstor A. Ramírez, MD, MPH

# World War II

## 1939-1945



# Plan for the Session

- Historical background for WWII
- Casualties and Injuries
- WWII Weapons
- Triage and transport of wounded
- Hospitals
- Diseases, Antibacterials and Antimalarials
- Blood loss and Circulatory shock
- Medical progress

# **HISTORICAL BACKGROUND for WORLD WAR II**

# World War II

## Precipitating Factors

- Territorial imperial expansions by Germany, Japan, Italy, Russia.
- Dictatorial nationalistic leaders like Stalin, Hitler, Mussolini, Franco, and Hirohito.
- Several nations were reluctant to rearm, like France, England, Poland.
- USA never ratified Treaty of Versailles and WWI peace accords.

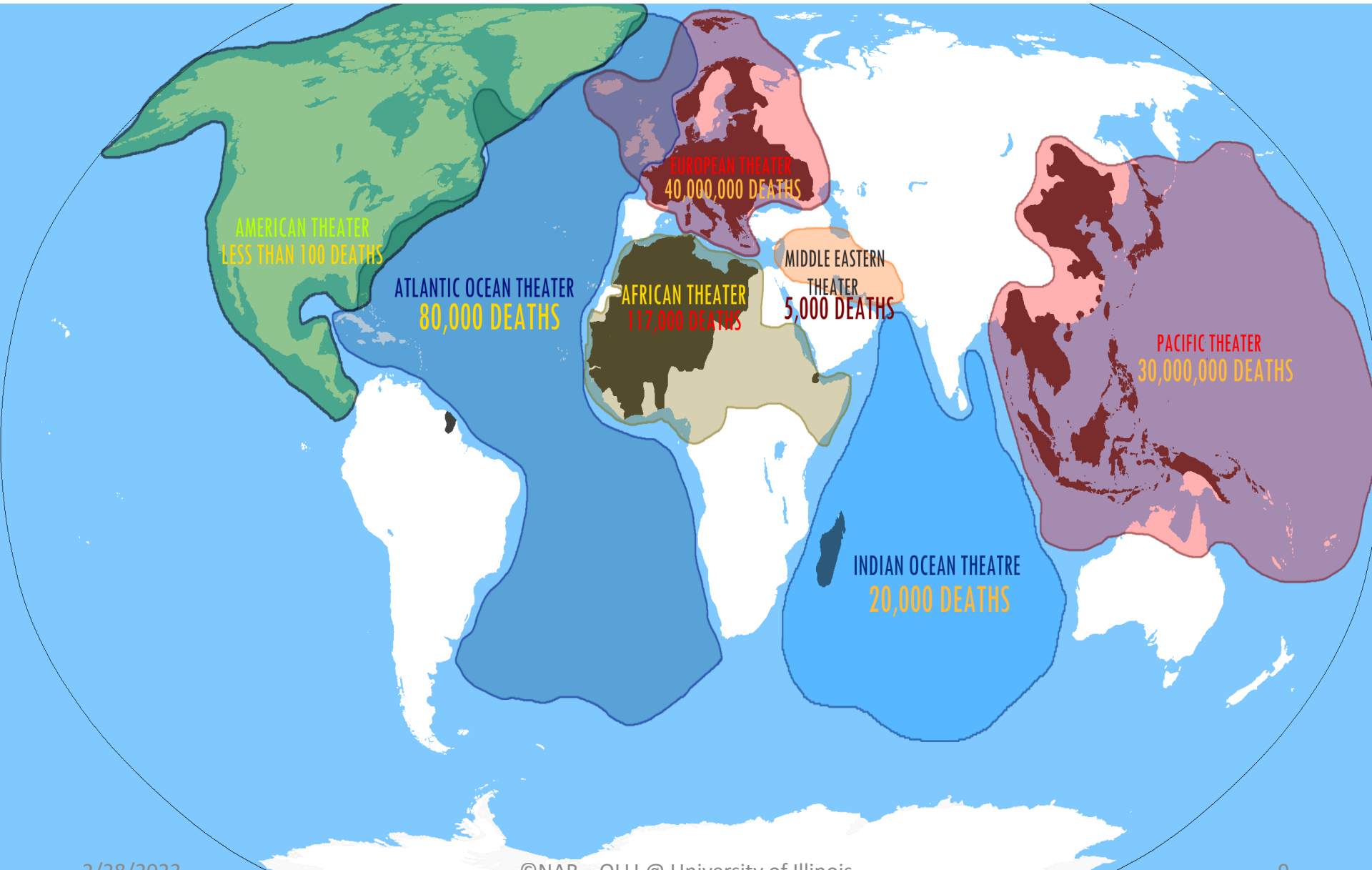
# World War II

1939-1945

- Two opposing military alliances:
  - the Allies: Soviet Union, UK, China, and US (1941)
  - the Axis: Germany, Japan, and Italy
- The deadliest conflict in human history, resulted in 70 to 85 million fatalities, mostly among civilians.
- Tens of millions died due to genocides (including the Holocaust), starvation, massacres, and disease.
- After The Axis defeat, Germany and Japan were occupied, and war crimes tribunals were conducted against their leaders.



# World War II Theaters of Operations



# World War II

## Women's Role



Rosie the Riveter

- US government and industry created the Women Ordnance Workers (WOW) using images of patriotism and women's strength to attract badly needed workers.
- WOW produced posters, badges, bandanas, and other items to foster the female workers' sense of pride and accomplishment while doing their part for the war effort
- About 300K workers brought on by Rosie's image, took on the dangerous work of operating heavy machinery, building weapons, and handling munitions.

# **CASUALTIES and INJURIES in WORLD WAR II**

# World War II

## Casualties and Injuries

An  
estimated  
total of  
70–85  
Million  
people  
died

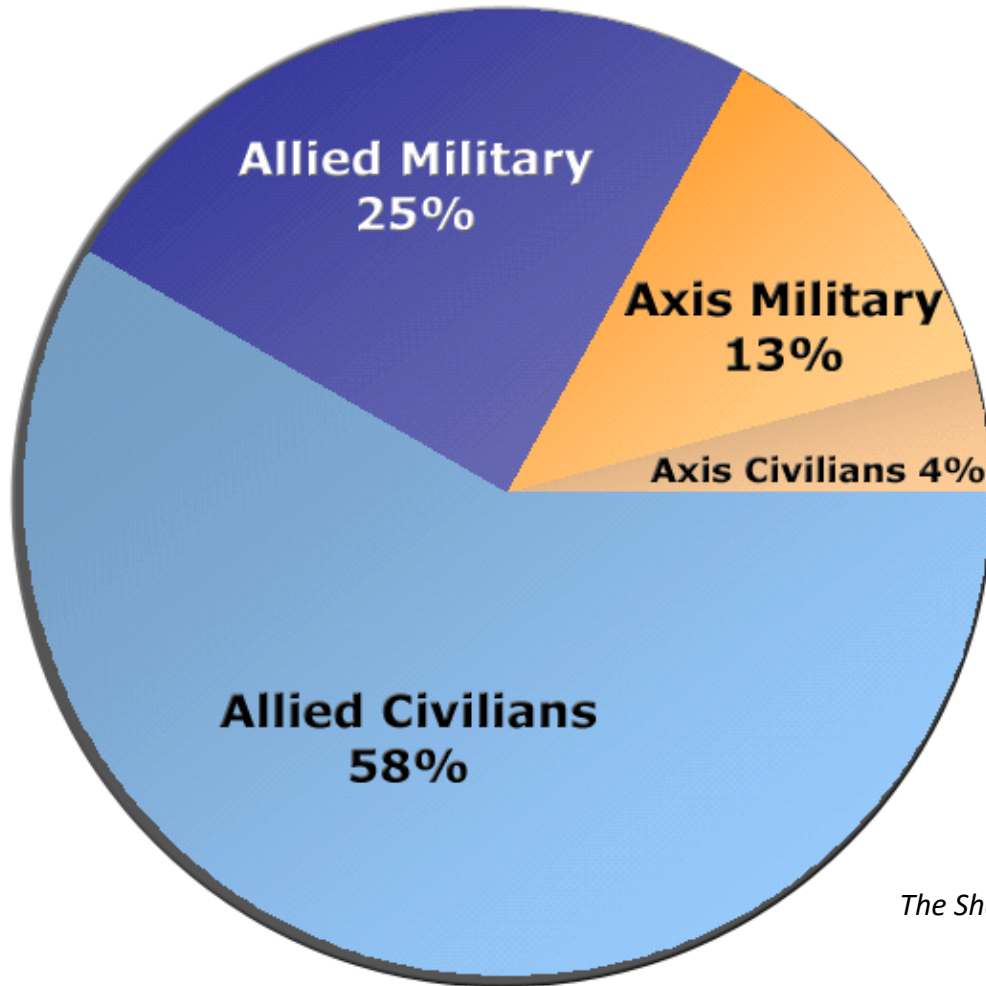
- Military deaths from all causes total 21–25 M including 5 Million POW deaths in captivity.
- Additional 19–28 Million deaths from war-related disease and famine.
- Civilian deaths estimated at 50-55 M.
- More than half of the total number are the dead of China and the Soviet Union.

# World War II

## Casualties and Injuries

- Civilian deaths from battles, bombardment, political and racial executions, war-induced disease, famine, and sinking of ships exceeded military battle casualties.
- Civilian deaths are very difficult to determine, but must be counted in any comparative evaluation of national losses.
- No reliable figures for the Soviet Union and China, the two countries with undoubtedly the greatest casualties.

## World War II Deaths



Whatever the total death estimates, these are the approximate percentages.

*The Shadowed* at English Wikipedia 2008

# World War II

## Casualties and Injuries

- Between 22M and 30M military deaths for all countries, with at least 40M civilians dead.
- More than 460K Americans were killed, and an additional 670K were wounded.
- These numbers are so high for two main reasons:
  - The highly populated locations of the war
  - New technology introduced in the war.

# World War II

## Casualties and Injuries

- Some Allied powers deaths:
  - USSR: perhaps 18,000,000.
  - Poland: 5,800,000 (20% of prewar population)
  - France: about 410,000
  - UK: about 383,700
  - US: more than 460,000
- Some Axis powers deaths:
  - Germany: about 4,200,000
  - Japan: about 1,972,000
  - Italy: about 330,00



# World War II

## US Casualties and Injuries

- Estimates are that 16,112,566 US soldiers participated in the battles of World War II.
- From Pearl Harbor to the Japanese surrender, 407,300 U.S. soldiers were killed.
- About 70% of those were combat-related, and 30% were accidents or illnesses.
- About 671,801 soldiers were seriously wounded or went missing.

## Main Campaigns, Locations, and Deaths of American Soldiers During WWII:

Battle	Location	Deaths
Battle of Normandy	France	29,204
Battle of Meuse-Argonne	France	26,277
Battle of the Bulge	B-L-G*	19,276
Central Europe Campaign	Central Europe	15,009
Battle of Okinawa	Japan	14,000
Battle of Hürtgen Forest	Germany	12,000
North Apennines Campaign	Northern Italy	8,486
Battle of Luzon	Philippines	8,310
Operation Anvil	France	7,301
Battle of Guadalcanal	Solomon Islands	7,100

\* B-L-G: Belgium, Luxembourg, Germany

# World War II

## US Casualties and Injuries

- There were also an estimated 12,100 civilian deaths due to crimes of war and military activity such as bombings.
- 130,201 soldiers were also captured by enemies as war prisoners.
- At the end of the war, 116,129 soldiers returned back to their homes.

# World War II

## Casualties and Injuries

- Soldiers faced a variety of injuries that ranged from insignificant to deadly.
- The most common was a gunshot wound, often from an enemy sniper.
- Usually, this would require surgery and could often end a soldier's military career.

# World War II

## Casualties and Injuries

- Flash burns from explosions of grenades or artillery were common and extremely serious.
- Other more natural afflictions included dehydration, hypothermia, and malaria.
- The most difficult injury to treat was *mental exhaustion*, known as PTSD today.

# World War II

## Casualties and Injuries

- Combat fatigue patients were given a safe place away from battle, with plenty of food and rest, so about 90% of patients recovered to return to battle.
- In the Pacific, malaria was a serious threat, so soldiers received *atabrine*, as prophylaxis and treatment.
- Service members were also vaccinated for flu, smallpox, typhoid, tetanus, cholera, yellow fever, depending where they were sent.
- Other WWII improvements included improved helmets, safety belts, flak jackets and other preventive measures.

# WWII WEAPONS

# World War II

## Weapons

- The use of machine guns, submarines, airplanes, and tanks was widespread in World War I.
- In WWII these weapons reached unprecedented perfection as killing machines in all war theaters.
- Small arms, land and sea artillery, torpedoes, armor-piercing and antipersonnel bombs took a terrible toll on human life.



# World War

## Weapons

- War is the greatest and quickest motivator of advances in technology and innovation.
- During the war, the Axis and Allies created aircraft that were increasingly more advanced.
- This culminated in the world's first jet fighter, the Messerschmitt Me262.

# World War II

## Weapons

- On the ground, highly effective tanks such as the Panther and T-34 came to rule the battlefield.
- At sea, equipment such as sonar decreased the U-boat threat, and aircraft carriers came to rule the waves.
- The US became the 1st to develop and use nuclear weapons.

# World War II

## Weapons

- Garand M-1 replaced the bolt-action M1903 Springfield as the U.S.' service rifle in 1936.
- The M1 was a semiautomatic bolt-free rifle with **8-bullet** magazines.
- The German Karabiner 98k Mausers were bolt-action rifles with **5-bullet** magazines.

# World War II

## Weapons

- America's first major encounter at Pearl Harbor showed what modern warfare really meant.
- Strafing aircraft, exploding ordnance, and burning ships caused many injuries:
  - penetrating wounds
  - simple and compound fractures
  - traumatic amputations
  - blast injuries
  - horrific burns

# **TRIAGE and TRANSPORT of WOUNDED**

# World War II

## Triage and Transport of Injured

- US Army Medical Corps created a tiered system to perform lifesaving procedures close to the battlefield and more complex care at higher levels of care.
- Patient management and triage principles evolved with subsequent battles and the military kept improving the method, and increase patient survival rates.
- The adoption of this system in portable field hospitals is credited with improving the survival rates of individuals with abdominal wounds.

# World War II

## Triage and Transport of Injured

- A WWII victim received professional treatment faster than a WWI casualty on the battlefields.
- Specialist surgical facilities were nearer to the front lines, and transportation was by car, plane, train or ship.
- Psychiatrists were closer to the front lines for patients who had endured psychological trauma.
- WWI's *shell shock* evolved into *battle weariness*, reflecting a deeper grasp of the complexities of emotional trauma.

# World War II

## Triage and Transport of Injuries

- Navy corpsmen provided first aid to Marines and Sailors.
- Army Medics did the same for soldiers.
- Army and Navy doctors and nurses were also forward-stationed at US sites worldwide.



## Normandy 1944, Evacuation by Litter



US National Archives

# C-47 Carries Injured, Germany to France, March 1945



# World War II

## Triage and Transport of Injured

- Regimental Aid Posts were frequently set up in cellars and buildings near the battleground.
- The Army Blood Transfusion Service made transfusions readily available worldwide.
- On the home front, specialists improved the treatment of burns and plastic surgery.

# World War II

## Triage and Transport of Injured

- The military kept improving the tiered triage method, which resulted in a significant increase in patient survival rates.
- Advances in triage guided appropriate patients to higher levels of care, allowing the greatest good to be done for the most casualties.
- The chaotic scenario involving many injured people was brought under control, allowing effective care to be delivered to each victim.

# World War II

## Triage and Transport of Injured

- Medical personnel at sea, in a remote disaster area, or in a battle zone, may have no opportunity to evacuate patients, so they must triage and treat accordingly.
- Personnel-to-casualty ratios, equipment accessibility, provider skill sets, and availability of communication, evacuation, and supply influence each decision.
- Distance, time, and weather, along with bewilderment, exhaustion, and panic, may all play a role.

# World War All

## Triage & Reverse Triage

- Triage is not democratic, and it necessitates making difficult judgments.
- Tactical scenarios such as a *return to war* or a *fight to save the ship* may take priority over “best practices” medical care.
- This is referred to as “*reverse triage*,” in which **the lightly injured are treated first to resume combat.**

# **PORTABLE and MOBILE HOSPITALS**

# World War II

## Portable hospitals

- The concept of portable/mobile hospitals was the realization that care needed to be fluid and able to move with the soldiers.
- It required structures that could be set up and broken down quickly and transported easily.
- Cost, use of scarce wartime materials, and no training needed to set up were vital factors.



# World War II

## Quonset Huts

- They were economical in use of materials.
- The unassembled buildings were portable, and prefabricated for easy erection and removal.
- They should be in any of three widths: 16, 24, or 30 feet, and any length, in multiples of 6 feet.
- They needed to be packed in a standard Army wagon and erected by six men in four hours.

# Quonset Hut Hospitals



# World War II

## Quonset Huts

- The US-made Quonset hut of WWII was inspired by the Nissen Hut of WWI.
- By war's end, 154K Quonset huts had been made.
- They were used as hospitals, semi-permanent housing, military camps, offices, store rooms, etc.
- Tens of thousands of surplus units were sold for civilian use after the war.

# World War II

- US Army had 3 main different Theaters of Operation:
  - European Theater of Operations, US Army (ETOUSA)
  - Mediterranean Theater of Operations, US Army (MTOUSA)
  - Pacific Theater of Operations, US Army (PTOUSA)
- In the Mediterranean theater, a single army operated on a single land mass, within a relatively limited area.
- In the European theater, there were 5 operating armies, each with its own commander, operating within a very large area



# US Army Hospitals in WWII

Battlefield  
*to*  
Hospital



## Normandy 1944, Evacuation by Litter



US National Archives

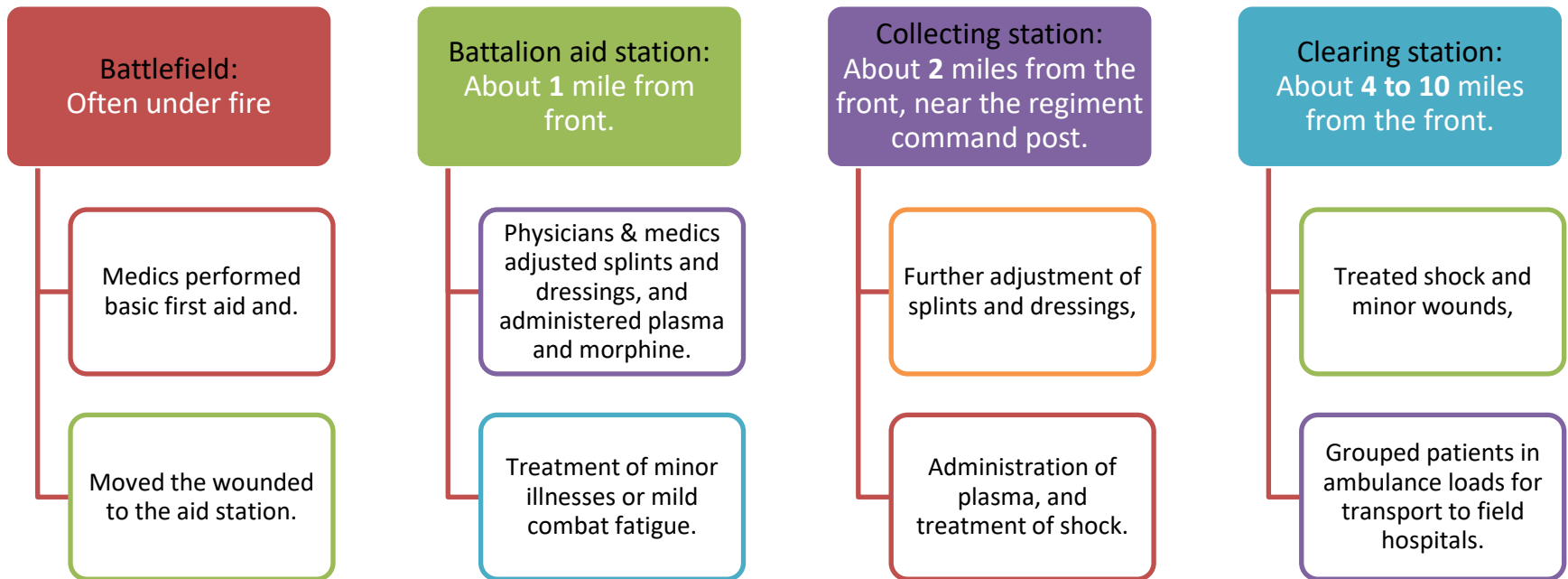
# Air and Land Ambulances, Normandy 1944



US National Archives

# WWII Chain of Care

These units were attached to combat units and followed them into battle:





# US Army Hospitals in WWII

Mobile  
&  
Fixed  
Hospitals



# World War II

## Battle Hospitals

- Designed to address acute traumas from bullets, artillery, bayonets and others weapons of war.
- Placed close to battlefields in the front, to maximize patients' chances of surviving injuries.
- Staffed with surgeons and nurses with special training and expertise in treating war casualties.
- Caring for soldiers through specific focus on their injuries improved survival rates for men wounded in battle.

# World War II

## Military Hospitals

- To achieve speed and conservation, the War Department converted existing civilian buildings into Army Hospitals.
- Congress approved the acquisition of civilian buildings to house additional General Hospital beds.
- Many additions and alterations had to be made after suitable buildings were found and acquired.
- By the end of 1943, the US Army had acquired enough civilian buildings to house 23 Hospitals and expand 5 others.

# World War II

## Military Hospitals

- After war broke out in Europe, the US Army increased its authorized peacetime strength.
- As Congress approved mobilization, the Medical Dept. had to expand its operations accordingly.
- For the US Army to provide an adequate hospitalization and evacuation system, expansion of US installations was necessary.
- New Hospitals were created and the staff of existing ones increased.

# World War II

## Military Hospitals

- Wartime medical treatment occurred on muddy battlefields under fire, in tent hospitals only miles from the front, and in sterile stateside hospitals.
- A complex chain moved patients to where they could best be treated.
- At all points along this chain, decisions were made regarding when to treat, when to return to duty, and when to evacuate further to the rear.

# WWII Hospitals

## Mobile Hospitals

Complete hospitals with nursing care, surgical & medical wards, X-ray, laboratory, and pharmacy, that could be packed and moved quickly to follow the battle lines.

- **Field Hospitals:** Within 30 miles of clearing station.
  - The wounded arrived within one hour of injury.
  - Surgery was performed for the most severe cases.
- **Evacuation Hospitals:** Treated illnesses and less urgent surgical cases, so that patients could be reconditioned to return to the front.

# World War II

## Mobile US Field Hospital

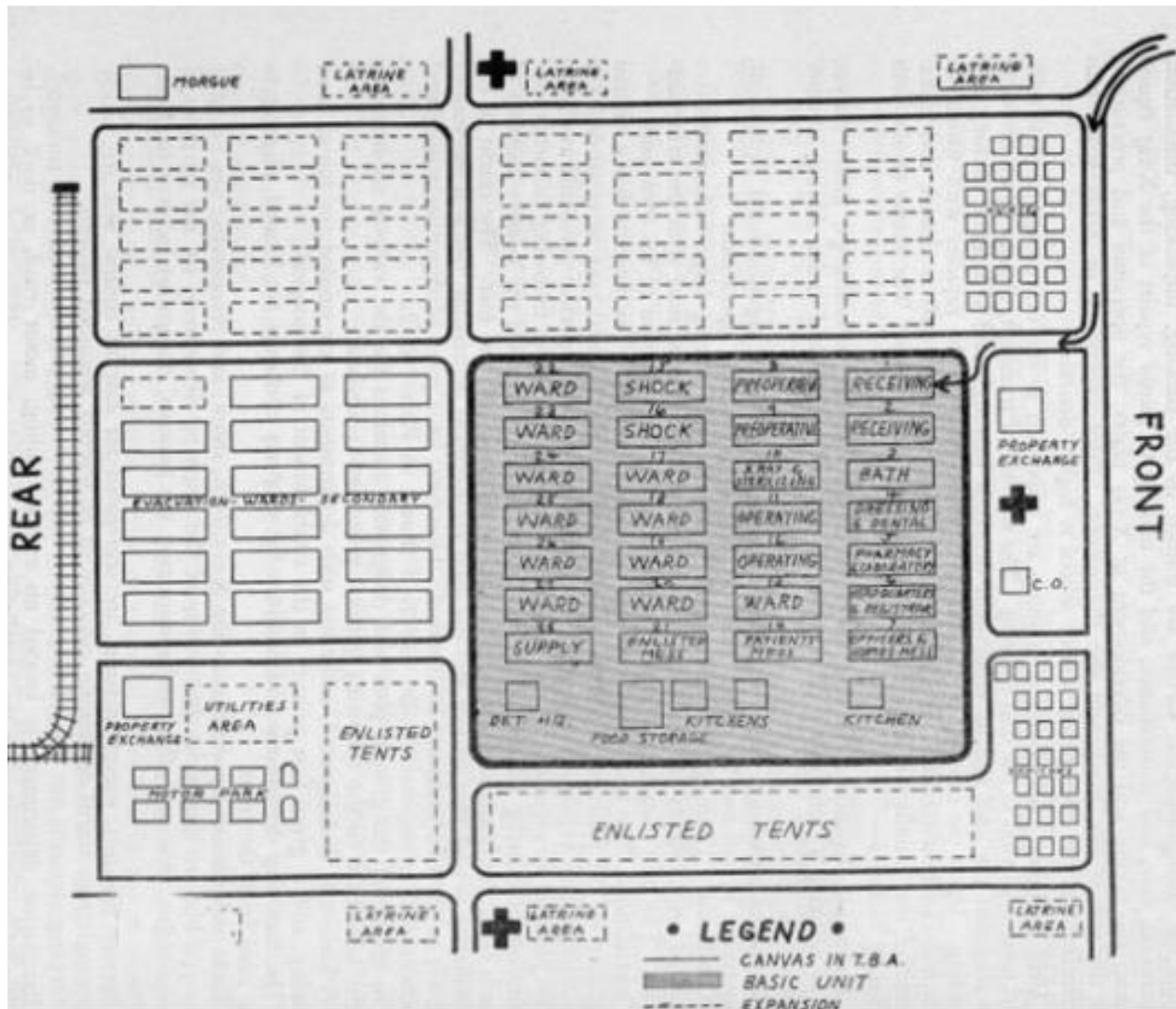


# World War II

## Mobile US Evacuation Hospital







Conventional arrangement of an Evacuation Hospital.  
 A basic unit could comprise up to 27 tents.

# WWII Hospitals

## (Fixed Hospitals)

Set up a safe distance from the front, either in the theater or stateside, they tended to remain in one location for longer periods of time.

- **Station Hospitals:** Usually attached to a military base, designed to treat illnesses and injuries among personnel stationed at that base.
- **General Hospitals:** Large facilities sometimes grouped in large complexes, for long-term or specialized treatment for certain types of wounds or illnesses, such as for craniocerebral, spine, eye, chest, or neuropsychiatric care.
- **Convalescent Hospitals:** Designed for rehabilitation of the severely wounded soldier who would eventually receive a medical discharge. This type of hospital was a World War II innovation.

# **DISEASES, ANTIBACTERIALS, ANTIMALARIALS**

# World War II

## Typhus

The RF Typhus Team chose some Arab villages for trials, but they would need to apply louse powder inside clothing without undressing the wearer.

With a hand duster, they pumped the DDT or MYL dust up sleeves, skirts, neck openings and waistbands.

The villagers enthusiastically turned up for treatment when they saw its effectiveness.

Louse powder acquired a reputation as a cure for insomnia and became a black-market commodity.

# World War II

## Vaccines

- As WWII went on in Europe, the US military saw that infectious disease was as dangerous an enemy as any other on the battlefield.
- So they made a new partnership with industry and academia to develop vaccines for the troops.
- The military liked vaccines because they very effectively reduced the number of troop sick days.

# World War II

## Sulfa

- 1<sup>st</sup> and only effective antibacterial available before penicillin, it was heavily used in early WWII.
- Saved the lives of tens of thousands of patients, including FDR Jr. (son of President FDR) and Winston Churchill.
- American soldiers were issued a first-aid kit containing sulfa powder and were told to sprinkle it on any open wound to prevent infection.
- Sulfonamide is a bacteriostatic because it can stop bacterial growth, but it can't kill them; the white blood cells in the body can do that.

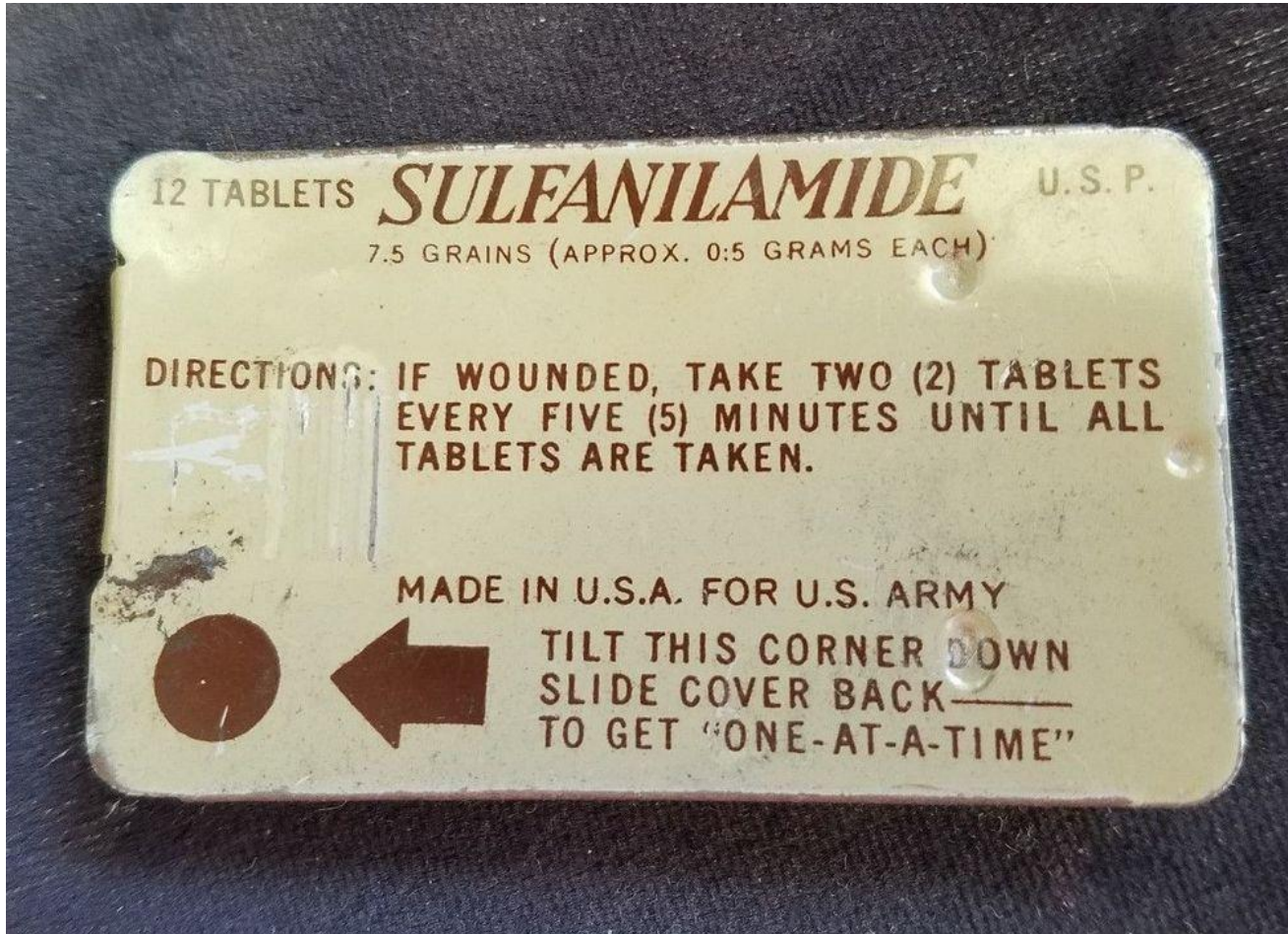
# World War II

## Sulfa

- Japanese troops did not have a ready supply of sulfa drugs, so they had more bacterial diseases like dysentery and pneumonia.
- Sulfa drugs made pneumonia and other infections less deadly.
- Sulfa drugs could damage the kidneys and the bacteria built up resistance after frequent use.

# World War II

## Sulfa





# World War II

## Sulfa

- Japanese troops did not have a ready supply of sulfa drugs, so they had more bacterial diseases like dysentery and pneumonia.
- Sulfa drugs made pneumonia and other infections less deadly.
- Sulfa drugs in large doses could damage the kidneys and the bacteria built up resistance after frequent use.

# PENICILLIN

# World War II

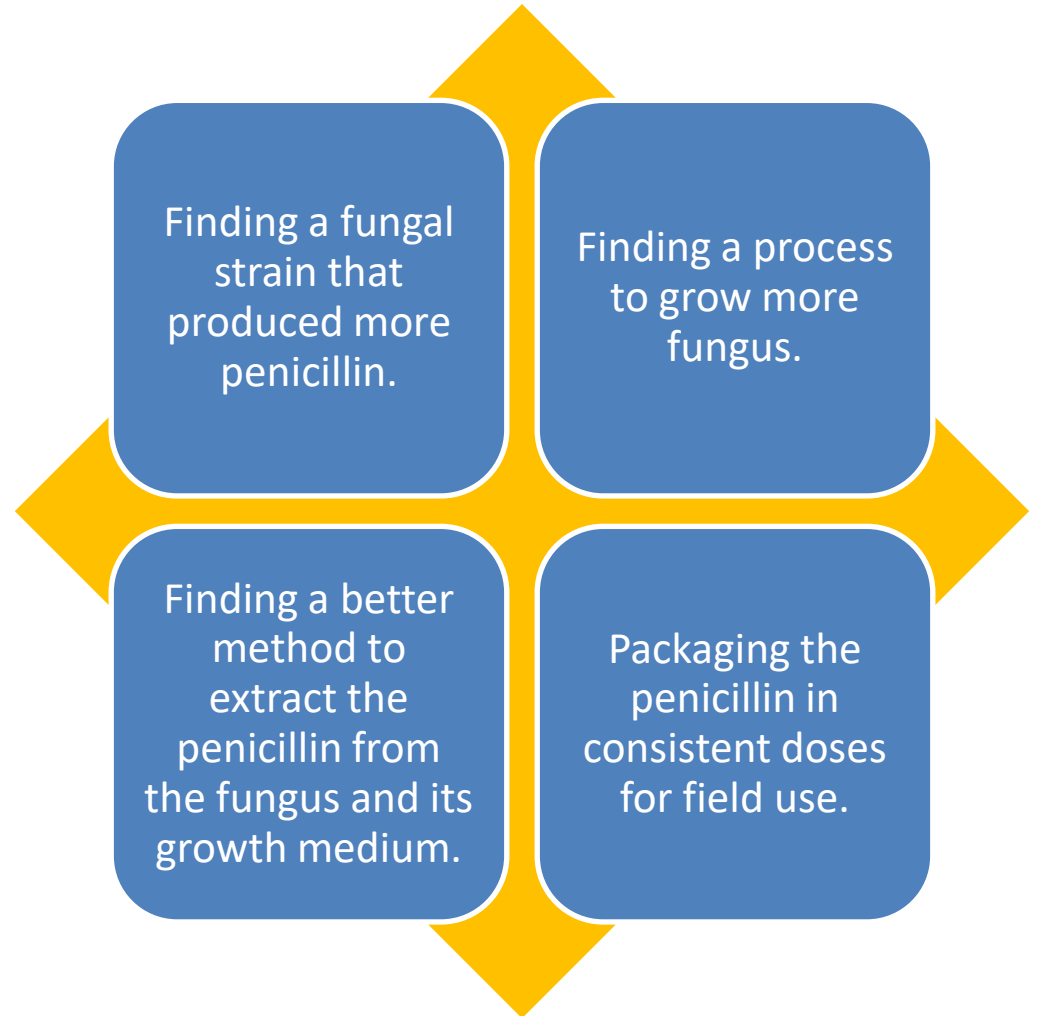
## Penicillin

- Discovered at St. Mary's Hospital in London, by Alexander Fleming in 1928.
- Published a paper and did a presentation to the Medical Research Club.
- There was no interest, and several chemists said that penicillin production for therapeutic use was almost impossible.

# World War II

## Penicillin

A year before D-Day, the War Production Board laid out a 4-step plan to provide enough penicillin for all Allied troops.



# World War II

## Penicillin

- Howard Florey, from the Nobel Institute, led the Oxford University research team that came to the US to develop penicillin as an antibiotic drug.
- Working first with Merck, they tested a potential drug on a patient with sepsis.
- Patient survived, but they ran out of penicillin.

# World War II

## Penicillin

- They found a cantaloupe in a lunchroom at the Northern Regional Research Lab with a very potent *Penicillium* growing on it.
- Chemical engineer Margaret Rousseau developed a fermentation plant to grow large quantities of the fungus.
- Pfizer participated in the packaging and dosing.
- Doses were available for the D-Day invasion, saving an estimated 15% of the wounded from death or amputation.

# World War II

## Penicillin

The team showed that *Penicillium* extract killed different bacteria:

- *Gonococcus*
- *Meningococcus*
- *Streptococcus*
- *Staphylococcus*
- *Anthrax* bacteria
- *Actinomyces*
- *Anaerobes* that cause tetanus and gangrene

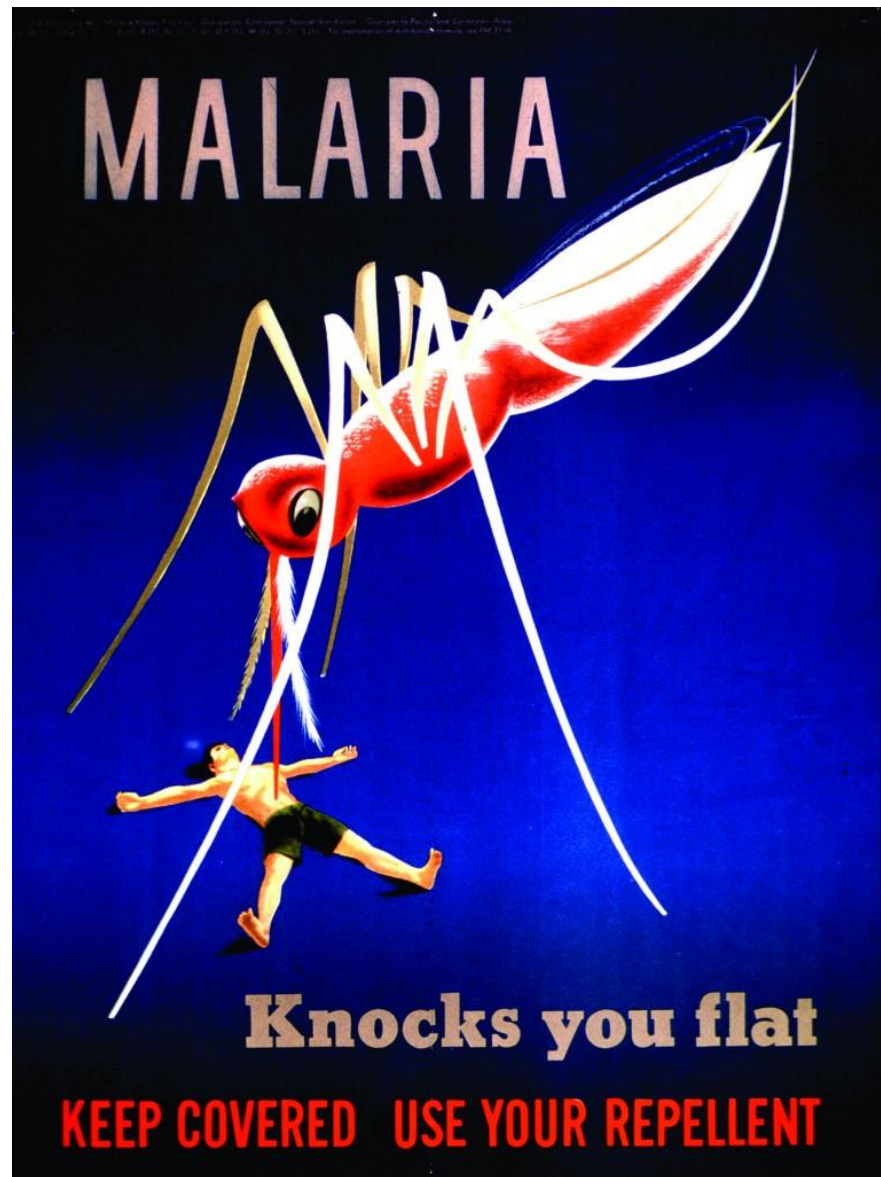
# Thanks to PENICILLIN

...He Will Come Home!





# MALARIA



# World War II

## Malaria

- US soldiers met two different types of the disease in the PTO:
  - Benign: causes violent chills, fever, and weakness
  - Malignant: a form much more likely to cause death.
- Both types could turn a soldier into a bedridden hospital case in a very short period of time.
- As troops retreated from the Japanese assault in 1941, they abandoned large amounts of medical supplies.

# World War II

## Malaria

- In 1942, about 24K of the 75K American & Filipino soldiers fighting the Japanese invasion were suffering from malaria, but if they had been healthy, their defense against the 57K Japanese troops would have been more effective.
- The Army learned in the Philippines that malaria control was essential for the success of the campaign in the Pacific.
- Army reported an incidence of 251 cases per 1K soldiers per year, equivalent to every soldier getting it 4 times through the year.

# World War II

## Malaria

- At the outset of WWII, the world supply of quinine from cinchona bark was mostly under Netherlands control.
- Java was the world's largest processor of cinchona, and a monopoly consortium had been formed in Amsterdam.
- When the Nazis occupied the Netherlands in May 1940, they took over the warehouses and processing capabilities of quinine, and when the Japanese occupied Java, the raw supply of cinchona was also lost.

# World War II

## Malaria

- The Allies needed a substitute for quinine, and one such option was a synthetic compound known as *chloroquine*.
- It was highly effective against the malaria parasite, killing it before it can reach the stage of infectiousness and causing symptoms.
- It had such serious drawbacks that the Bayer company said that *chloroquine* was so toxic that it could not be practically or safely administered to humans.
- The most commonly used alternative was a synthetic drug, *quinacrine*, with the brand name *Atabrine*.

# World War II

## Malaria

- US and the Allies could produce *Atabrine* in the massive quantities to supply their troops with this essential drug.
- US Army made it their antimalarial of choice.
- Winthrop Chemical Co. increased production, delivering almost 1.8 B doses in 1943, and 2.5 B in 1944.
- However, supplying troops with sufficient quantities of *Atabrine* did not necessarily mean that they would take the medicine.

# World War II

## Malaria

- Rumors, aided by Japanese propaganda, claimed that prolonged use of *Atabrine* could lead to infertility.
- The Medical Corps put medics in chow lines to pass out the pills and watch each soldier take his dose.
- It was easy to miss doses in the heat of battle, when cut off from supply lines, or simply because a soldier decided that he didn't like the cost-benefit ratio.

# World War II

## Malaria

- *Atabrine* had several unique alarming side effects:
  - Turned the patient's skin a bright shade of yellow.
  - In rare cases, it caused neurological problems, like nightmares, anxiety, or full-blown psychosis.
- Giving soldiers a large initial dose, followed by daily maintenance doses reduced these effects.
- With this system, psychosis was observed in only about one-tenth of 1% of the GI's given *Atabrine*.



# Atabrine, It's not a Joke!



# World War II

## Malaria

- It was impossible to completely stop malaria, and in the end, about 60 to 65% of American troops in the South Pacific contracted it.
- When DDT was combined with *Atabrine* and other anti-mosquito measures, malaria rates could be reduced up to 70% of those seen in the early stages of the war.
- Thanks to the Army's propaganda, and supplies of insecticides and antimalarials, the US was able to minimize the effects of malaria on the war effort.

# **BLOOD LOSS and CIRCULATORY SHOCK**

# World War II

## Blood Loss

- Initially, only plasma was available as a substitute for lost blood volume.
- Dried plasma, made to be reconstituted with sterile saline at the battle sites was also available.
- By 1945, infusible serum albumin was developed.
- Whole blood is rich in red blood cells that carry oxygen and is more effective than plasma or albumin.

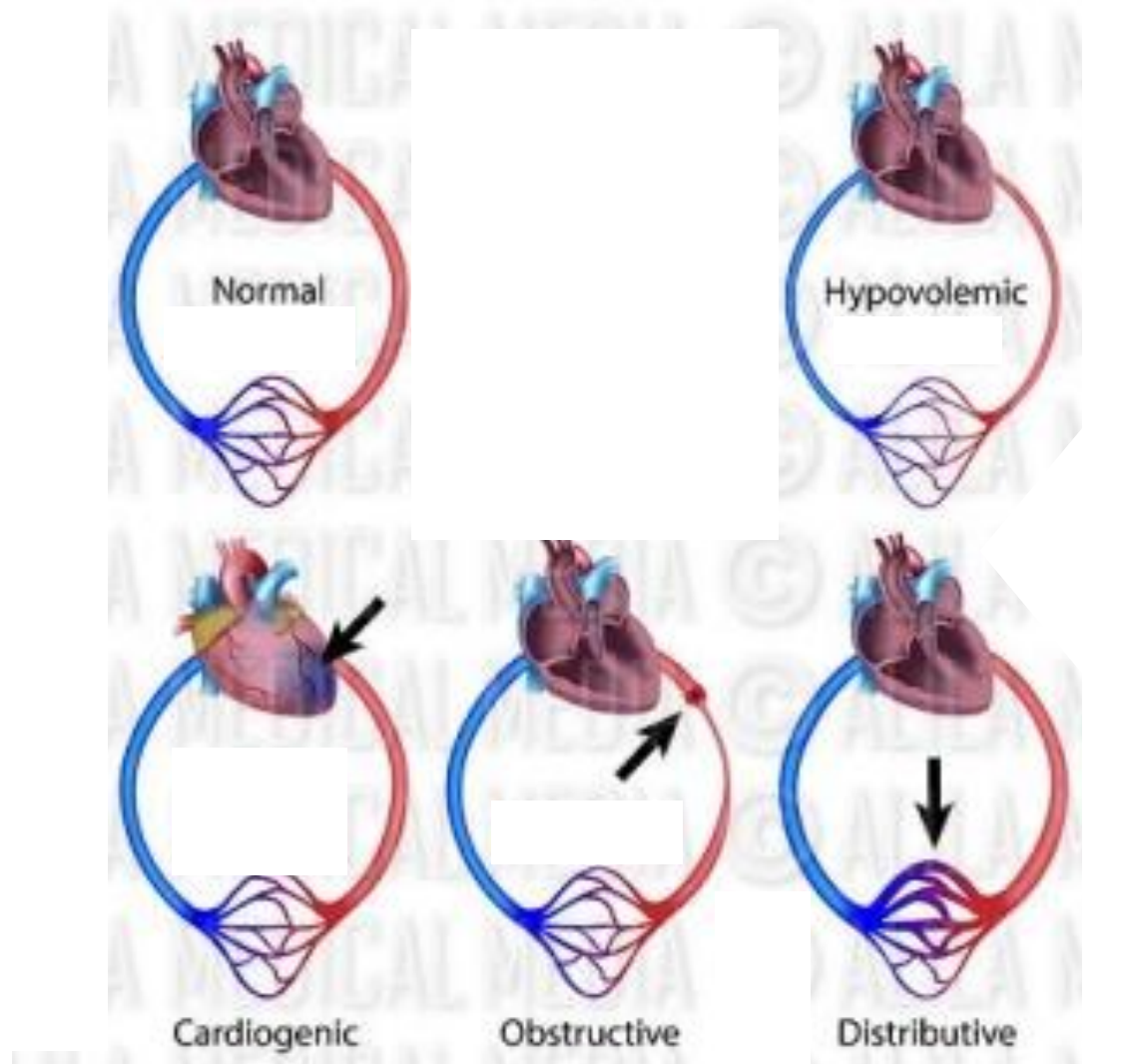
# Circulatory Shock

- State of insufficient blood flow (and therefore, of oxygen supply) to the body tissues as a result of problems with the circulatory system
- Four main types based on the underlying cause:
  - Hypovolemic: Low volume from losses (bleeding)
  - Distributive: Sepsis, anaphylaxis, cord injury, overdoses.
  - Cardiogenic: Heart attack, or cardiac contusion
  - Obstructive: Cardiac tamponade, pneumothorax

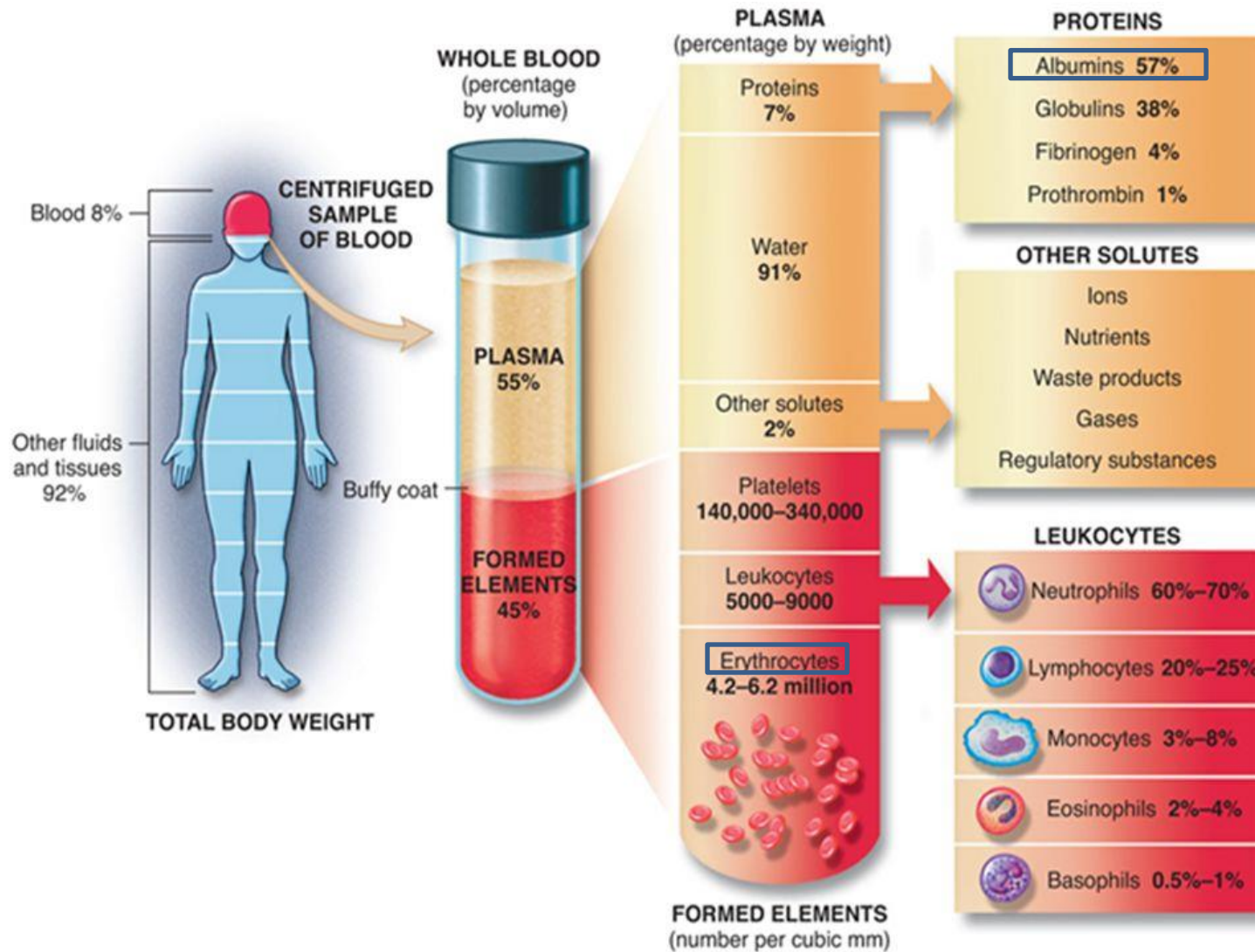
# Circulatory Shock

- Hypovolemic: faucet was opened, fluid lost
- Distributive: volume OK, container enlarged
- Cardiogenic: pump not working correctly
- Obstructive: Faucet blocked, no circulation

# Circulatory Shock



# Components of Blood





# World War II

## Human Serum Albumin (HSA)

- HSA is responsible for 80% of the colloid osmotic pressure of plasma.
- Introduced during WWII as a substitute for blood or plasma in expanding intravascular volume.
- The IV administration of albumin produces a rapid increase in circulating blood volume.

# World War II

## Blood Supply

- In the European theater, there were 5 U.S. Field armies, each with its own Army surgeon who had his own concepts of how to care for casualties and of their need for blood.
- Theater facilities could not possibly supply all the blood needed for casualties on the Continent.
- In the European theater, blood supply was always limited which never permitted storage in significant amounts.

# World War II

## Blood Supply

- In Italy, blood did not have to be flown across water, as from England to the Continent, or from the Zone of Interior to Europe.
- In Italy, medical control was uniform: there was a single army, and there was a single army surgeon.
- Bad weather was seldom a hindrance to the delivery of blood in Italy (Mediterranean theater).

# World War II

## Blood Supply

- Regimental Aid Posts were frequently set up in cellars and buildings near the battleground.
- The Army Blood Transfusion Service made transfusions readily available worldwide.
- On the home front, specialists improved the treatment of burns and plastic surgery.

# Plasma Administration



Omaha Beach, 1944



Okinawa, 1945



Sicily, 1943

# MEDICAL ADVANCES

# World War II

- WWII's new lethal weapons and massive armies made Medicine speed up changes in drugs and medical care.
- More men were dying from infections than from bullets and grenades, so medicine was forced to find better ways to treat infections.
- From the beginning, plasma – and later whole blood – was credited by the Surgeons General of the Army and Navy as being the greatest lifesaver of World War II.

# World War II

## Medical Advances

- During the war, surgery techniques like wound debridement resulted in fewer amputations.
- For the 1<sup>st</sup> time in large-scale combat, sulfa & penicillin were given for bacterial infections.
- This was the first major war in which air evacuation of the wounded became available.



# C-47 Air Ambulance, Normandy 1944



US National Archive

# World War II

## Medical Advances

- Penicillin, Blood Plasma and Sulfanilamide were considered the most important medical innovations during World War II.
- They had a tremendous impact on WWII because of the countless number of lives they saved.
- All of the medical advancements in WWII went on to benefit society after the war had ended.

# World War II

## Medical Advances

- DDT sprayed over broad areas reduced typhus and malaria outbreaks among troops and civilians.
- Because of improvements like these, the survival rate for the wounded and ill climbed from 4% in WWI to 50% during World War II.

# World War II

## Aftermath

- The United Nations was established to foster international co-operation and prevent future conflicts.
- The victorious great powers, China, France, Soviet Union, United Kingdom, and United States became the permanent members of its Security Council.