Battlefield Medicine

Session 4

World War I

OLLI Spring Semester 2023

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Plan for the Course

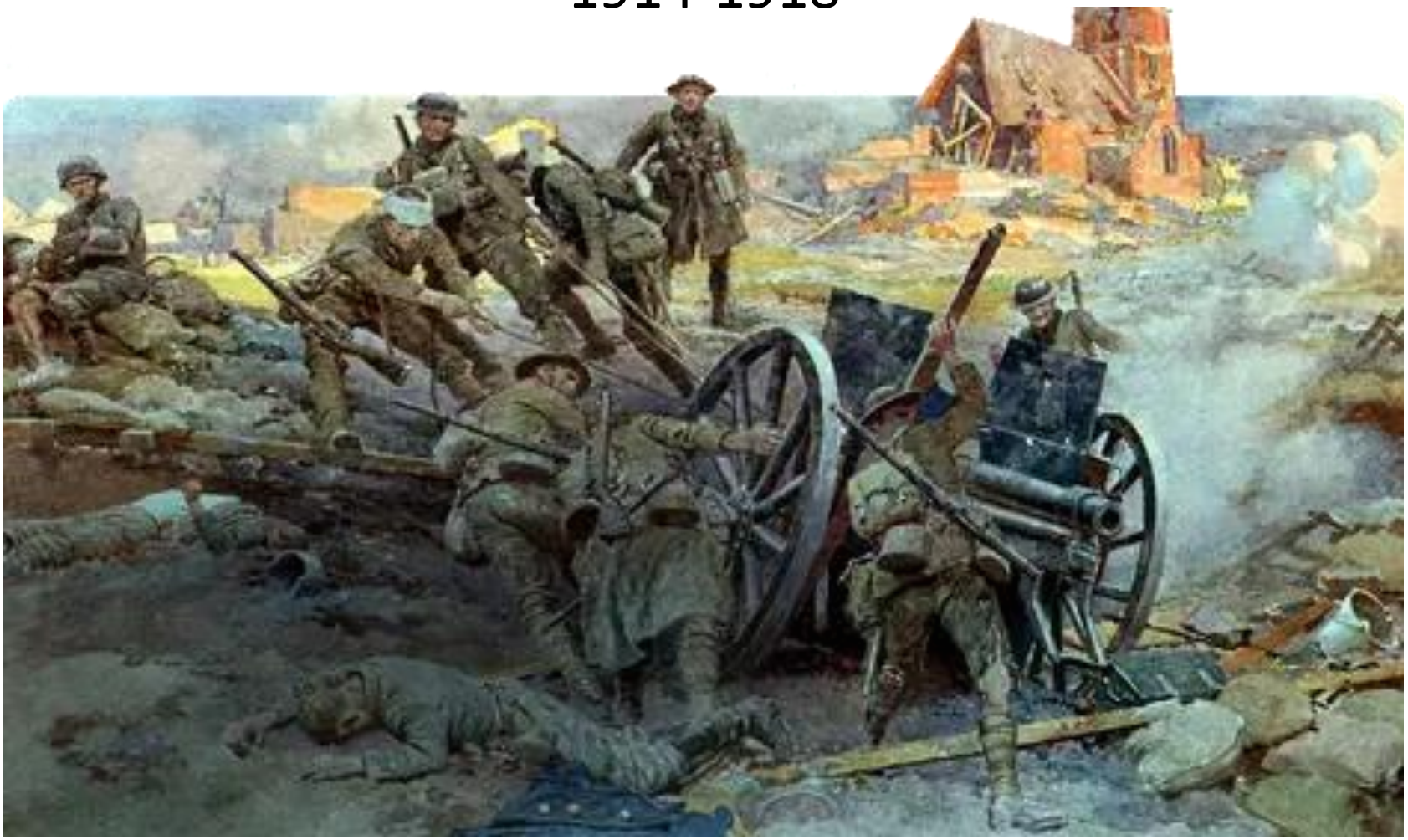
- Session 1: Ancient history, Rome, Greece.
- Session 2: Middle Ages, weapons & injuries.
- Session 3: US Revolutionary & Civil Wars.
- Session 4: World War I.
- Session 5: World War II.
- Session 6: Korea, Vietnam.
- Session 7: 20th & 21st Century Regional wars.
- Session 8: Peek into future, Nuclear War?

Plan for Session 4

- Historical Background for WWI/Western Front
- The Doughboys
- Shell Shock and Barbed-wire Disease
- Opium Addiction
- Endell Street Hospital
- Trench Diseases
- Poison Gases
- WWI Wound and Burns care
- Triage and patient transport
- Plastic Surgery

World War I

1914-1918



World War 1

- Involved most of the nations of Europe along with Russia, the United States, the Middle East, and other regions.

- Central Powers (mainly Germany, Austria-Hungary, and Turkey), against the Allies, (mainly France, Great Britain, Russia, Italy, Japan, and USA).

- It ended with the defeat of the Central Powers after unprecedented slaughter, carnage, and destruction.

World War 1

- World War I was one of the great watersheds of 20th-century geopolitical history.
- Caused the fall of 4 great imperial dynasties (Germany, Russia, Austria-Hungary, & Turkey).
- Laid the groundwork for World War II by destabilizing European society.

World War 1

- WWI signaled the end of conflicts which were settled with some semblance of chivalry.
- It was a war of rapidly changing technology, fought using tactics of the Napoleonic era.
- Companies of soldiers were thrown against squads of men with machine guns capable of firing 800 rounds a minute.

World War 1

- The war caused 350K total American casualties, of which over 117K were deaths.

- Considering that 4.450 M men were mobilized, and half of those went to Europe, 117K is far less than the casualty rates suffered by combatants in other theaters.

- Best estimates today are 53K combat deaths, and 64K deaths from disease:
  - Official figures in 1919 were 107K total
  - 50K combat deaths, and 57K deaths from disease
  - About ½ of the disease deaths were from the great influenza pandemic of 1918-1920.

The Western Front

- In August 1914, the Germany invaded Luxembourg, Belgium, and the industrial regions in France.

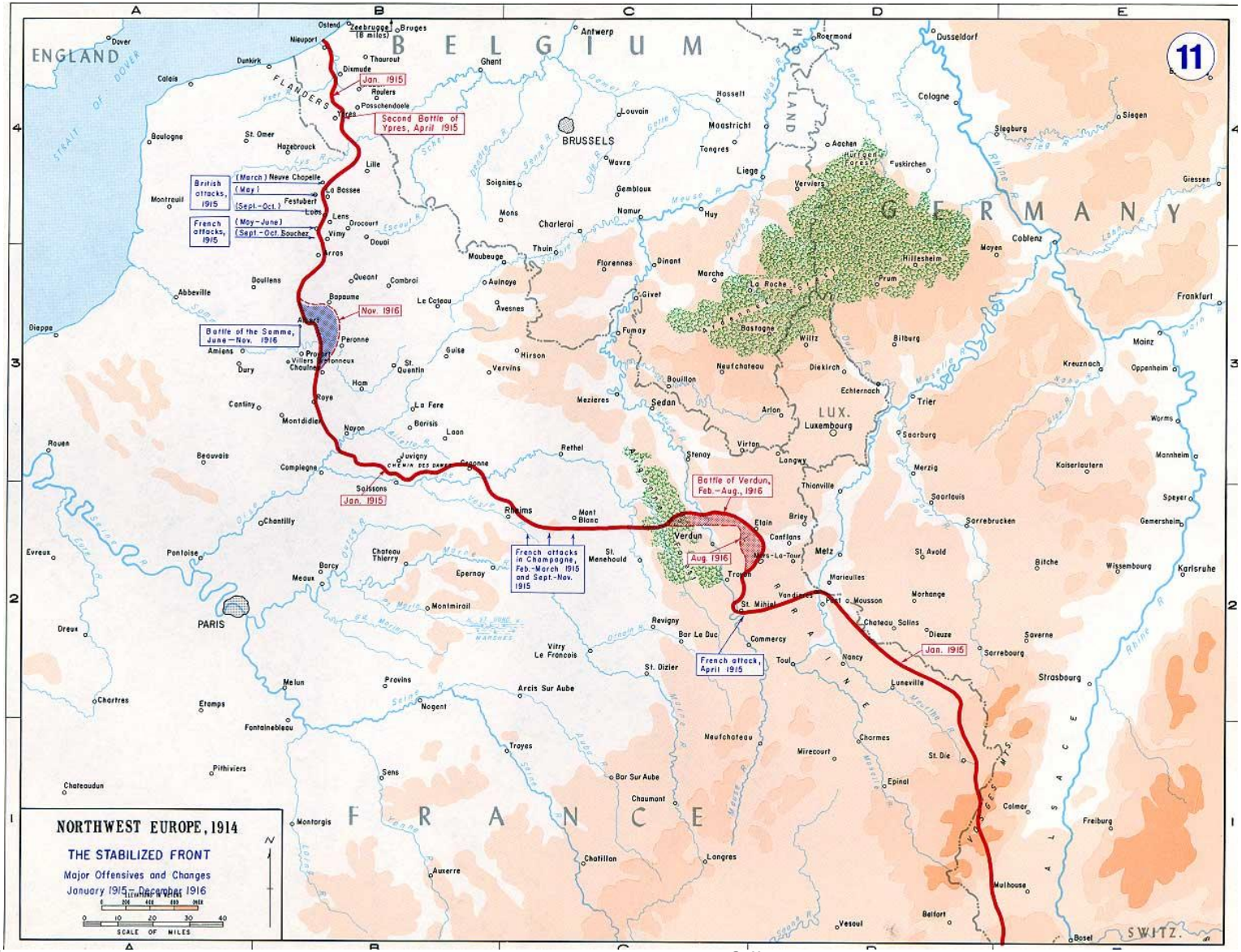
- After the Battle of the Marne, both sides dug in along a line of fortified trenches, stretching from the North Sea to the Swiss-France border, with little change until early 1917 -1918.

- Between 1915 and 1917 there were several attacks that employed massive artillery bombardments and massed infantry advances.

The Western Front

- The British and French armies fought to stop the German advance in the Battle of Marne which prevented the Germans from marching on Paris.
- To avoid losing the territory already gained in France, the Germans began digging trenches.
- The British and French unable to break through the line of trenches, began to dig their own trenches.
- Throughout the entire war, neither side gained or lost more than a few miles of ground along what became known as the Western Front.

The Western Front 1915-1916



The Western Front

- Entrenchments, machine gun emplacements, barbed wire and artillery inflicted severe casualties during attacks and counter-attacks without significant advances by either side.

- The most costly of these offensives were:
  - The Battle of Verdun (1916) with 700K casualties
  - The Battle of the Somme (1916) with >1M casualties
  - The Battle of Passchendaele (1917), 487K casualties

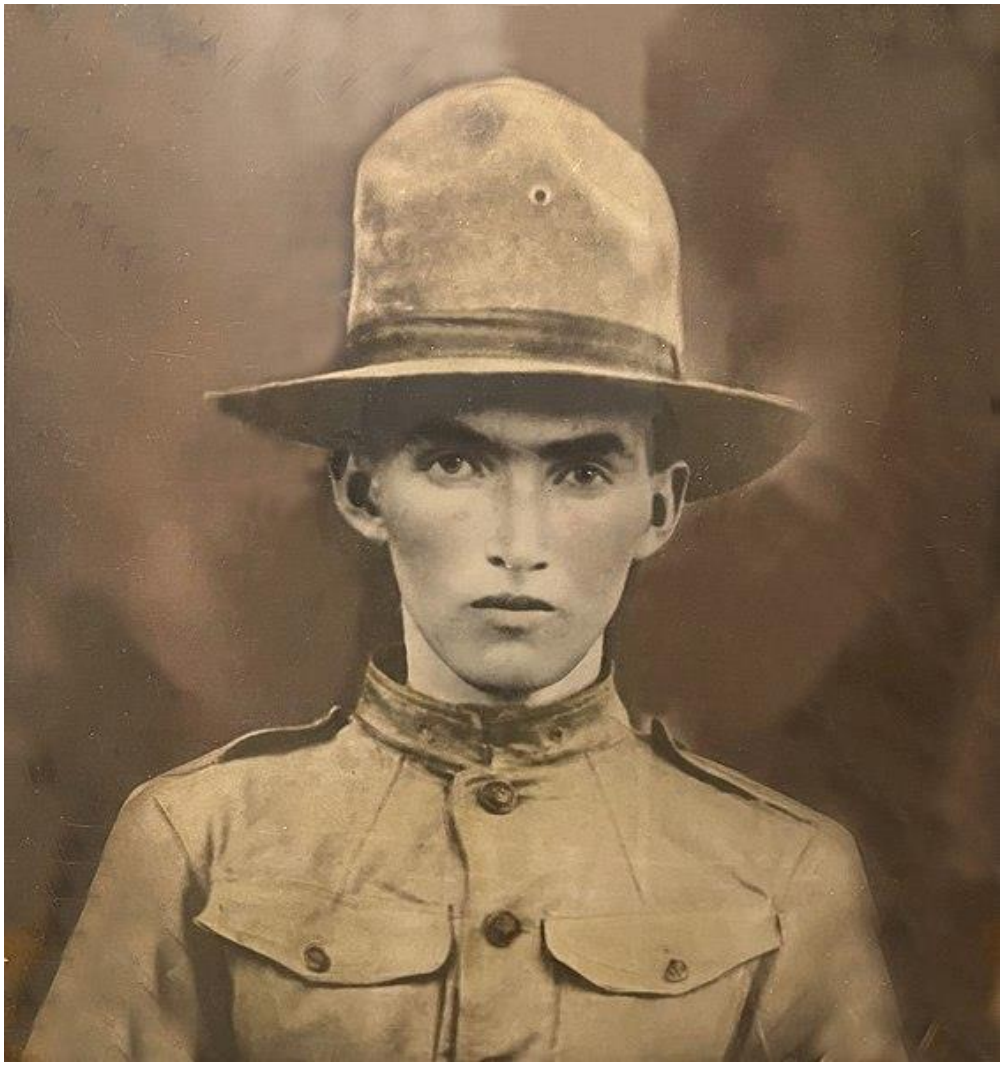
The Western Front

- The word stalemate entered the dictionary to describe a useless situation with no foreseeable conclusion.

- The result was 8.5 million dead and 21 million maimed and disabled, plus 12.5 million civilian casualties.

THE DOUGHBOYS

Doughboys



- In WWI doughboys were very young, with an average age less than 25 years old.
- Seventeen-year-old boys also enlisted to fight in World War I.

Doughboys

- British sailors and Wellington's soldiers in Spain, were familiar with fried flour dumplings called "doughboys“.

- As applied to the US Army infantry, it first appears during the Mexican–American War of 1846–1848.

- U.S. infantry forces were constantly covered with chalky dust from marching in northern Mexico, giving the men the appearance of adobe mud bricks: *adobes* transformed to *dobies* and then into *doughboys*

Doughboys

- 1 explanation is that female Salvation Army volunteers went to France to cook millions of doughnuts and bring them to the troops on the front line.

- One joke explanation for the term's origin was that, in WWI, the doughboys were "kneaded" in 1914 but did not rise until 1917.

- Australians and New Zealanders were called “diggers”, French were called “*poilu*” (hairy one), and the British were called “Tommies”.

Doughboys

Doughboys

SHELL SHOCK and BARBED WIRE DISEASE

Shell Shock

- Soldiers who endured the awful conditions of trench warfare and experienced the terrible artillery barrages of WWI, often developed a neuropsychiatric syndrome known as *shell shock*.

- Symptoms included uncontrollable trembling, headache, tinnitus, dizziness, memory loss, sleep disorders, inability to concentrate, and confusion.

- Some patients were barely able to walk, or had partial paralysis, or stammered uncontrollably, or were unable to talk.

Shell Shock

- The disease as seen in World War 1 had a strong neurologic component.
- Many of these patients may have had actual traumatic brain injury, at least to some degree, as well as PTSD.
- TW. Salmon, consultant in psychiatry, formulated the treatment used throughout the AEF.

Shell Shock

5 principles based on treating as far forward as possible:

- Immediacy: begin treatment early.
- Proximity: treat close to the soldier's unit.
- Expectancy: short-lived episode, quick return to duty.
- Simplicity: use simple treatments, like food, rest, sleep, and behavioral psychology.
- Centrality: have consistency treating all psychologic casualties.

Barbed Wire Disease

- People who had been in enemy captivity for extended periods (2 years or more) suffered from a mental illness characterized by disinterest in life beyond the camp, restlessness and an inability to concentrate.

- Seen in European and Indian POW's in Turkish captivity and among German civilian internees on the Isle of Man, and prisoners held in military and civilian camps on the British mainland

Barbed Wire Disease

- It is a universal human response to being held behind barbed wire for prolonged stretches of time.
- It was not limited to a pathological minority within camp communities, but was common to all long-term inmates.
- It was not eased or worsened by peculiarities in the educational, class, ethnic or religious background of any particular group of prisoners.
- Its sole cause was the fact of living behind barbed wire, and the degree of severity depended mainly on the duration of captivity, not on pre-capture experiences.

OPIUM ADDICTION

Opium Addiction

- During the American Revolution, both the Continental and British armies used opium to treat sick and wounded soldiers.
- The Union Army issued nearly 10M opium pills to its soldiers, plus 2.8M ounces of opium powders and tinctures.
- An unknown number of soldiers returned home addicted, or with war wounds that opium relieved.

Opium Addiction

- The hypodermic syringe was widely used to deliver morphine by the 1870's.
- Morphine could cure nothing, but it could relieve anything.
- Both doctors and patients were tempted to overuse.

Opium Addiction

- Opiates were 15% of all prescriptions in Boston in 1888 and they were also sold in an unregulated marketplace.

- Physicians prescribed them for a wide range of indications, and pharmacists sold them to individuals medicating themselves for many physical and mental discomforts.

- In the 19th century, when a physician prescribed an opiate for a patient, neither physician nor patient had a lot of alternatives.

WORLD WAR I HOSPITAL "MANNED" by WOMEN

Endell Street Hospital

- When war broke out in August 1914, women doctors who volunteered their services to the British War Office were rejected.

- Louisa Garrett Anderson (the daughter of Elizabeth Garrett Anderson) and her partner Flora Murray did not waste time offering their skills to the British Army.

- 8 days after Britain declared war on Germany, they approached the French Red Cross, who immediately accepted their help.

Endell Street Hospital

- In Paris, they received the luxury Hôtel Claridge, as their emergency hospital.
- The hotel had no lighting, heating or hot water, and the plaster on the walls was still damp.
- In less than 48 hours, the women turned the dining rooms into wards and set up 100 camp beds.
- The ladies' cloakroom was converted into an operating theatre, with a fish kettle for a sterilizing unit, and the grill room became a mortuary.

Endell Street Hospital

- That same evening, 50 wounded men arrived on stretchers, and the surgical team worked through the night.
- Anderson & Murray were wholly unprepared.
- They had no experience in military surgery and had never operated on men.

Endell Street Hospital

- But the scale and complexity of the wounds they saw, most of them with gangrene, were new to **all** surgeons.
- British Army officials, who came to view the novelty of a women-run hospital, were quickly convinced of their efficient proficiency.
- In early 1915, the head of the RAMC, invited them to run a major military hospital on Endell St., London.
- After closing their units in France, they went to London.

Endell Street Hospital

- After many struggles, they recruited 180 staff, including 14 doctors, 29 trained nurses and more than 80 orderlies - all women.

- By early May, the 5-floor Endell Street Military Hospital had 17 wards, an operating theatre, an X-ray room, a theatre and a 5K book library.

- Knowing that the men were ‘more wounded in their minds than in their bodies’, Anderson and Murray ensured the wards were homely and cheerful, with bright quilts and fresh flowers.

Endell Street Hospital

- Endell Street stayed open throughout the war, treating 26K patients, who arrived in convoys, often at night.

- Its doctors performed more than 7,000 major operations and pioneered medical advances.

- It was hailed a triumph by the press and described by its patients as the ‘best’ in London.

Endell Street Hospital

- After the war, it stayed open for 1 more year, treating victims of the influenza pandemic.
- It finally closed its doors in late 1919.

TRENCH DISEASES

Trench

- There were 3 diseases called 'Trench' diseases that became significant on the Western Front during the 4 years of the war.
- All of these diseases had previously been recorded in many campaigns, but never on the scale of the Western Front.
- The general public were largely unaware of the drain these diseases caused on the morale and fighting efficiency of the troops at the front.

Trench Diseases

- Throughout history, even small concentrations of soldiers have suffered from outbreaks of disease, particularly associated with static warfare such as sieges, or over-wintering in encampments:
  - Trench Foot
  - Trench Mouth
  - Trench Fever
  - Other infectious diseases

Trench Foot

- Virtual immobility of soldiers in the trenches meant they were forced to spend long hours with their feet exposed to the wet and cold.

- After days of continuous exposure, the skin of the feet becomes waterlogged, chilled, the blood circulation is restricted, and the feet become very painful.

- The skin breaks down, feet get swollen, blisters form, and eventually they became numb from nerve damage.

Trench Foot

- Over 20K trench foot casualties were recorded by the British on the Western Front in the winter of 1914/15.

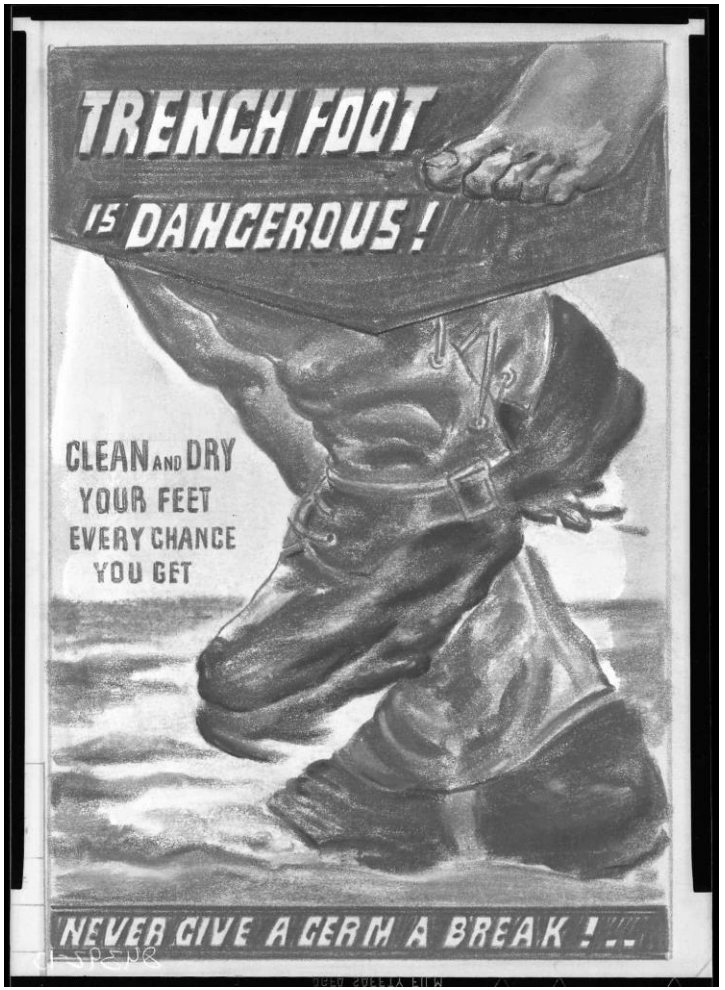
- This stimulated preventive action:
  - Frequent foot inspections of the troops by Medical Officers.
  - Additional pairs of dry socks made available so they could be changed several times a day.
  - Whale oil was rubbed onto the feet by soldiers who would vigorously apply it to each other's feet.
  - Circulation was stimulated, and the whale oil would help to avert the waterlogging of the skin.

Trench Foot

Preventive Care

Trench Foot


THIS IS
TRENCH FOOT
Prevent it!
KEEP
FEET
DRY
AND
CLEAN


TRENCH FOOT
IS DANGEROUS!
CLEAN AND DRY
YOUR FEET
EVERY CHANCE
YOU GET
NEVER GIVE A GERM A BREAK!..

Trench Fever

- Body lice caused a disease that became to be known as 'Trench Fever'.

- The organism (*Rickettsia quintana*), was transmitted by scratching of the skin that forced the infected feces of the louse into lice bites.

- The infected soldier did not show any signs, or symptoms, for 2-3 weeks, then a severe head-ache developed with debilitating muscle pains, characteristically of the shins.

Trench Fever

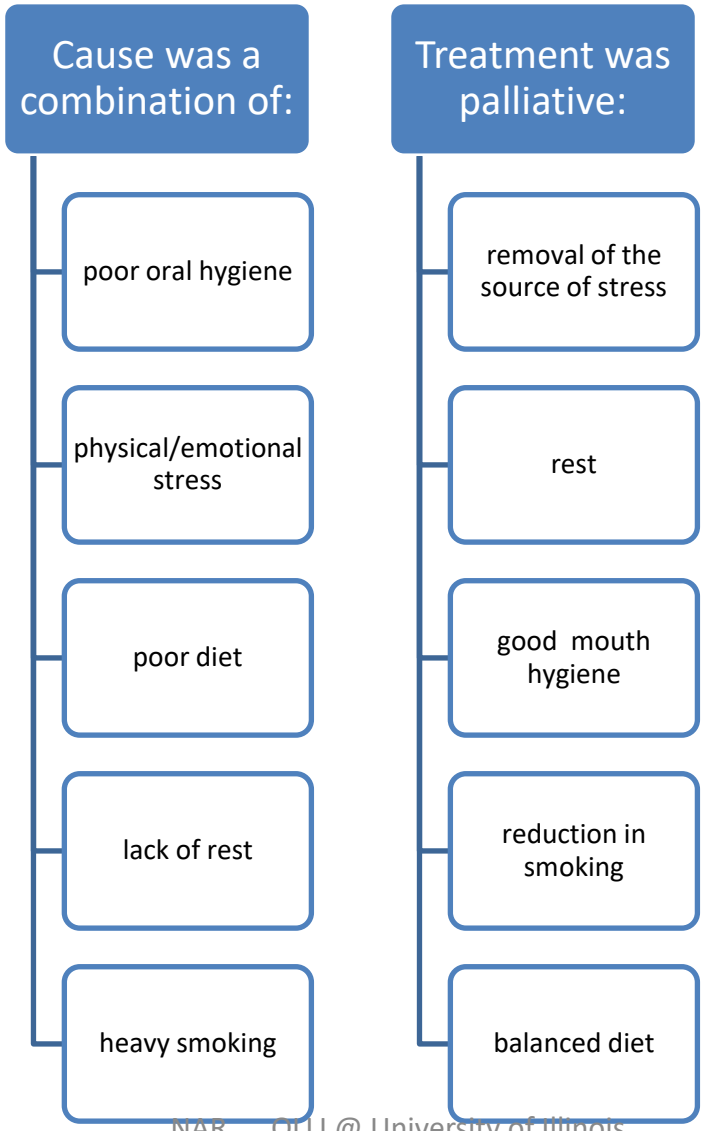
- At about 5days the fever went into remission and often reoccurred one or more times.
- Besides bed rest there was no good treatment for Trench Fever but serious depression was a common complication.
- Fatalities were rare, but 80% of affected men remained unfit for duty for up to 3 months.
- During the war, 800K cases of Trench Fever occurred in the British Army,

Trench Mouth

- Acute Necrotizing Ulcerative Gingivitis.
- Caused by overgrowth of normal mouth-dwelling bacteria (*Bacillis fusiformis*) and spirochaetes (*Borrelia vincentii*).
- They eroded the gums, with bleeding, ulceration, sloughing of the gum membranes and bad breath.
- Pain was such that eating, swallowing, and even talking, became difficult.

Trench Mouth

All of these factors were abundant in WWI trenches.



All of these remained in short supply throughout the duration of the war.

WWI WOUND CARE

Artillery Injuries

- Shrapnel from bursting artillery shells causes large, ugly, wounds with a great deal of tissue damage.
- Foreign material was carried into the wound, including dirt from the trench environment.
- Frequently, the unfortunate soldier was also buried in the collapsed trench

WWI Wounds

- Media emphasizes machine guns, rifles and bayonets, but the reality is that 2/3 of all casualties on the Western Front were produced by artillery shells.

- Machine guns and rifles used the same ammunition, and they produced most of the other 1/3 casualties.

- Bayonet wounds were so uncommon that they were tabulated under “miscellaneous wounds” in the hospital log books.

World War 1

Wound Care

- Military surgeons learned that trying to close battlefield wounds early frequently resulted in closed wound infections.

- Most battlefield wounds were left open for subsequent closure.

World War 1

Wound Care

- Effective local and general anesthesia allowed surgeons to take the time they needed to debride and repair wounds.
- Debridement, including excision of devitalized tissue, became standard surgical treatment.
- Recognition that bacterial contamination causes post-operative infections helped to develop aseptic surgery.

World War 1

Dakin's Solution

- Strong germicidal solutions, like carbolic acid (phenol) or iodine, either damage living cells or lose their potency in the presence of blood serum.

- Dakin's solution has neither disadvantage; its solvent action on dead cells hastens the separation of dead from living tissue.

- Dakin's solution is prepared by passing chlorine into a solution of sodium hydroxide or sodium carbonate.

World War 1

Carrel-Dakin Method

- First used early in the war, when Major Alexis Carrell was serving in the French Medical Corps and later became universal in the treatment of wounds.

- Sodium hypochlorite, a mild antiseptic, when used in simple irrigation of wounds with water or saline helps to clean wounds, and reduces bacteria.

- Dakin's solution is available today, although with the increasing use of antibiotics, it is used much less today.

World War I

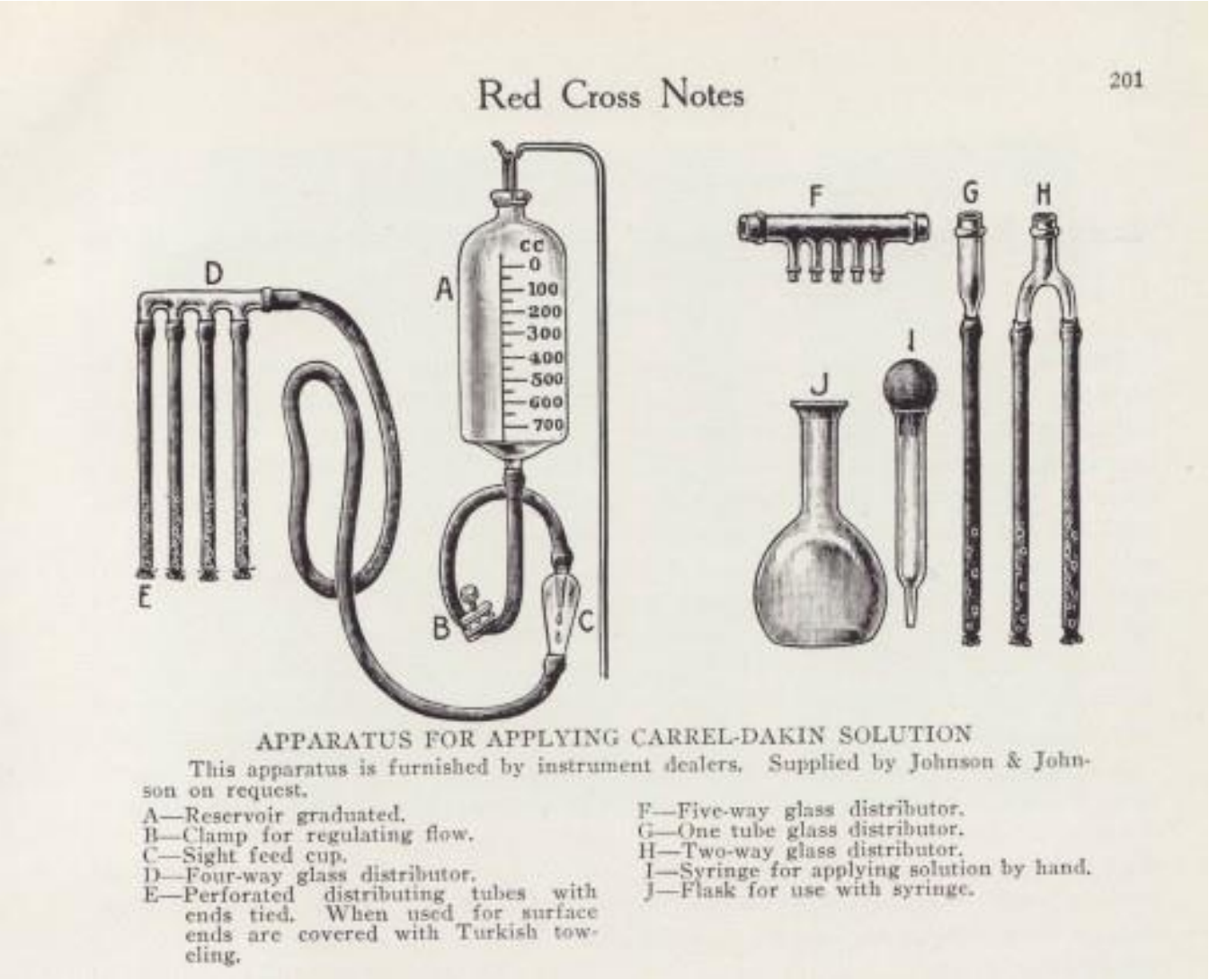
Dakin's Solution

- Also called Carrel-Dakin fluid, is a dilute sodium hypochlorite solution (commonly known as bleach).

- Sodium peroxide mixed with hydrochloric acid make a sodium hypochlorous acid similar to that produced in human neutrophils and is a potent antibacterial.

- It does not damage living cells or lose potency in the presence of blood serum, but has a solvent action on dead cells that separates dead tissue from living tissue.

Carrel-Dakin Apparatus



APPARATUS FOR APPLYING CARREL-DAKIN SOLUTION

This apparatus is furnished by instrument dealers. Supplied by Johnson & Johnson on request.

A—Reservoir graduated.
B—Clamp for regulating flow.
C—Sight feed cup.
D—Four-way glass distributor.
E—Perforated distributing tubes with ends tied. When used for surface ends are covered with Turkish toweling.
F—Five-way glass distributor.
G—One tube glass distributor.
H—Two-way glass distributor.
I—Syringe for applying solution by hand.
J—Flask for use with syringe.

Tetanus

- Tetanus antiserum was routinely given to patients with wounds heavily contaminated with dirt.

- Improved surgical techniques combined with the use of antiserum were credited at the time with the virtual elimination of tetanus.

GANGRENE

Gangrene

- Gas gangrene and *clostridial myonecrosis* are used to describe an infection of muscle tissue by toxin-producing *clostridia*.

- The organism, originally known as *Bacillus aerogenes capsulatus,* was later renamed *Bacillus perfringens,* and is now *Clostridium perfringens*.

- In World War I, gas gangrene complicated 6% of open fractures and 1% of all open wounds.

Gangrene

- Anaerobic *Clostridia* were buried underground in land that had been fertilized with manure.
- Trench warfare digging disrupted and churned up the soil.
- The whole front consisted of churned-up soil from artillery rounds and the digging of deep trenches.

Gangrene

- *Clostridium* bacteria release toxins that destroy blood cells, blood vessels and muscle tissue.

- This causes severe blisters, skin discoloration swelling, and widespread inflammation.

- The bacteria create gas that gives wounds a foul smell when they open.

Gangrene

- When a soldier was injured, his wounds could come into contact with bacteria from manure which lurked in the trenches in the fields.

- Most of the wounds were grossly dirty and quickly foul-smelling, and were usually contaminated with more than one kind of bacteria.

- Many bacteriae work quickly and produce toxins which cause severe pain, gaseous swelling, and rapid breakdown of muscles (*myonecrosis*) so that urgent and radical surgery is required to save limbs and lives.

TRIAGE and PATIENT TRANSPORT

Triage

Formulated by Jean Larrey, the chief surgeon of Napoleon's Grand Armée, it divides patients into three categories:

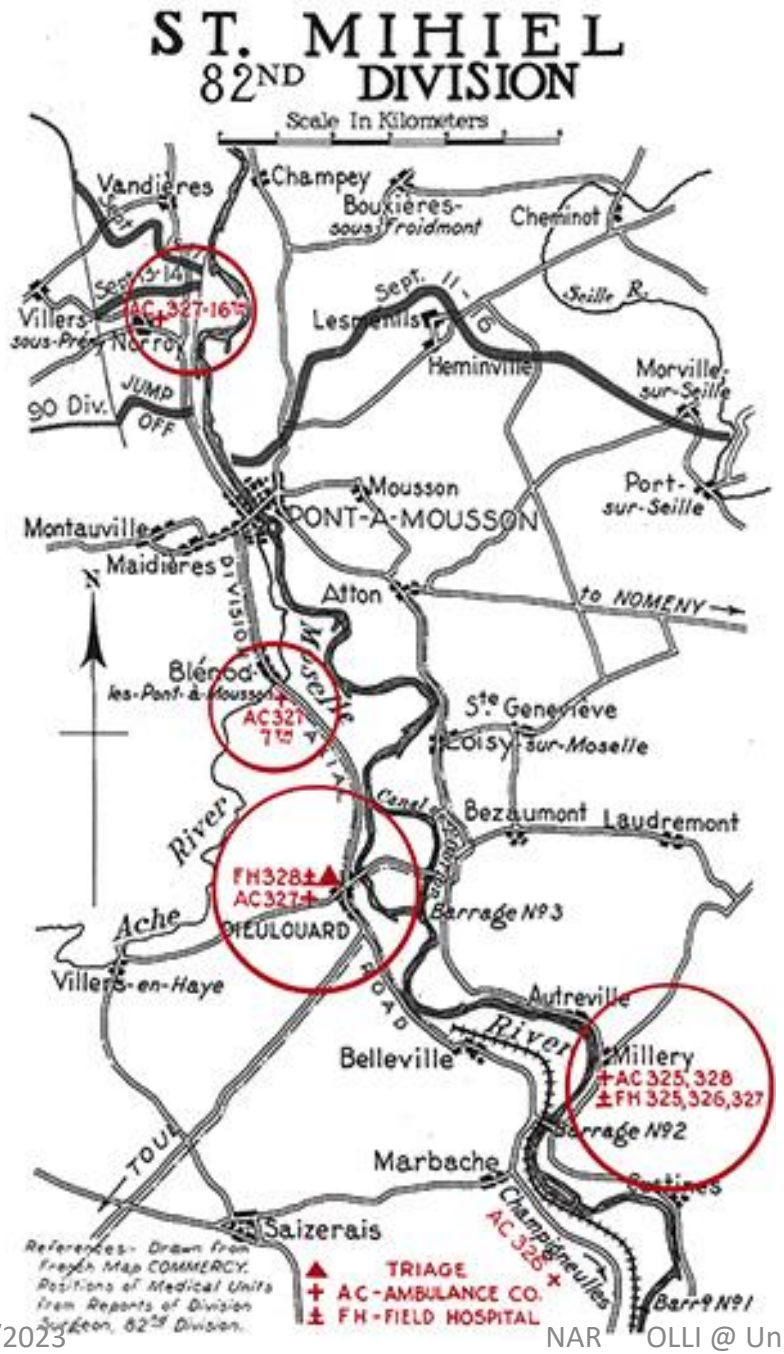
- **1**. Those who will recover with minimal care, or even with no care.
- **2**. Those in whom immediate intervention may be life-saving, and who may die without that.
- **3**. Those who are unlikely to live, regardless of treatment.

Triage

- It requires abandoning some patients to die, in order to spare resources for those who can be saved with reasonable effort.

- Efforts to try to salvage one patient who is likely to die, use time and resources that might be used to save the lives of several less severely wounded.

- Civilian medicine is not usually practiced this way, outside of disasters, but on the battlefield, time and resources are finite.



WWI Triage

Location of Positions of Medical Units/Triage facilities of Battle of St. Mihiel, 1918, based on report of the 82nd Division's Surgeon.

WWI Ambulances

- First responders for soldiers wounded in the first few weeks of World War I were the ambulance units.
- Ambulance drivers drove their horse wagons and carriages up to the front lines to transport the wounded back to the safety of the triages.
- As artillery improved in range and accuracy, battlefield triages, and hospitals were moved further back behind the front, exacerbating the load of already strained horse-carriage ambulances.

WWI Ambulances

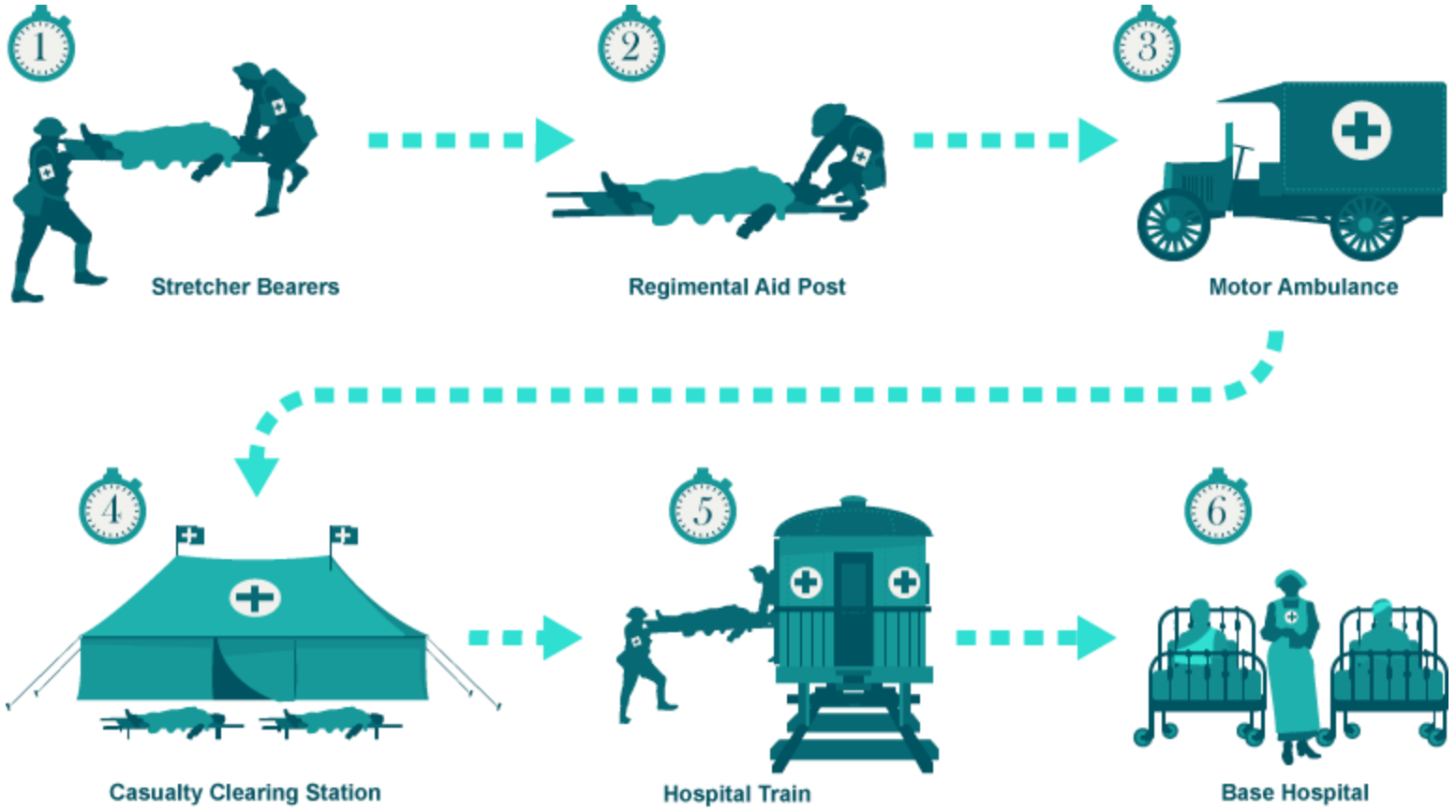
- Richard Norton organized the first modern ambulance corps using motor ambulances in October 1914.
- Norton's American Volunteer Motor Ambulance Corps was the US 1st ambulance volunteer unit to serve with the French & British.
- Norton often wrote letters to American industrialists in Detroit, pleading for donations of new vehicles.
- By 1917, Norton's fleet of American ambulances and drivers was awarded the Grand Cross of the Legion of Honor, France's highest decoration for foreigners.

WWI Ambulances

- The American Ambulance Field Service (later American Field Service, AFS), another volunteer ambulance division, chose to be affiliated directly with the French Army.
- Norton's American Ambulance Corps affiliated with the American Red Cross.
- The American Ambulance Corps and the Field Service used college students, graduates, and university faculty volunteers in their ambulances.

World War I

Moving Casualties



BURNS

Burns

- Major burns - 50% or more of the body area - were generally fatal.
- Burns of the face and extremities, while not often fatal, could still produce major disability.
- IV fluids were used in World War I, but surgeons did not realize that early and aggressive IV fluid therapy was key to survival for large burn injuries.

Burns

- Small areas could be adequately treated with:
  - supportive care
  - reducing infection
  - full-thickness skin grafts

- The need to provide better treatment of burn wounds stimulated a great deal of research by plastic and trauma surgeons after WWI.

Burns

- Burn etiologies included:
  - fire
  - scalding
  - bombs
  - gunpowder
  - explosive grenades
  - illuminating rockets (flares)
  - inhalation/contact injuries from gas

- Pathology was complicated by concurrent lacerations, dirt, gangrene, bone fractures or chemical absorption.

Burns

- In the 1800's there was little understanding and much misinterpretation of the process and treatment of burns.
- Prior to the 1800's, burn care consisted of different applications of poultices and oils over acute burns in the hope the patient would survive.
- Curling and Marjolin's ulcers were discovered in the 1800's.
- Physicians got the first understanding of inhalation injury and the burn disease process, and made advancements in skin grafting, with further understanding of burns.

Burns

- Pain was treated mostly with opium, morphine, laudanum, and often alcohol, like brandy or whiskey.

- Anesthesia included chloral hydrate, chloroform & ether.
-
- Antisepsis was achieved by steam sterilization of dressings & instruments, & the use of iodine & Carrel-Dakin's solution.

- Dressings were soaked with oils to achieve bacteriostasis & optimize healing.

- Burn protective covering included mixtures of paraffin/white wax.

- Surgical treatment included debridement and grafting.

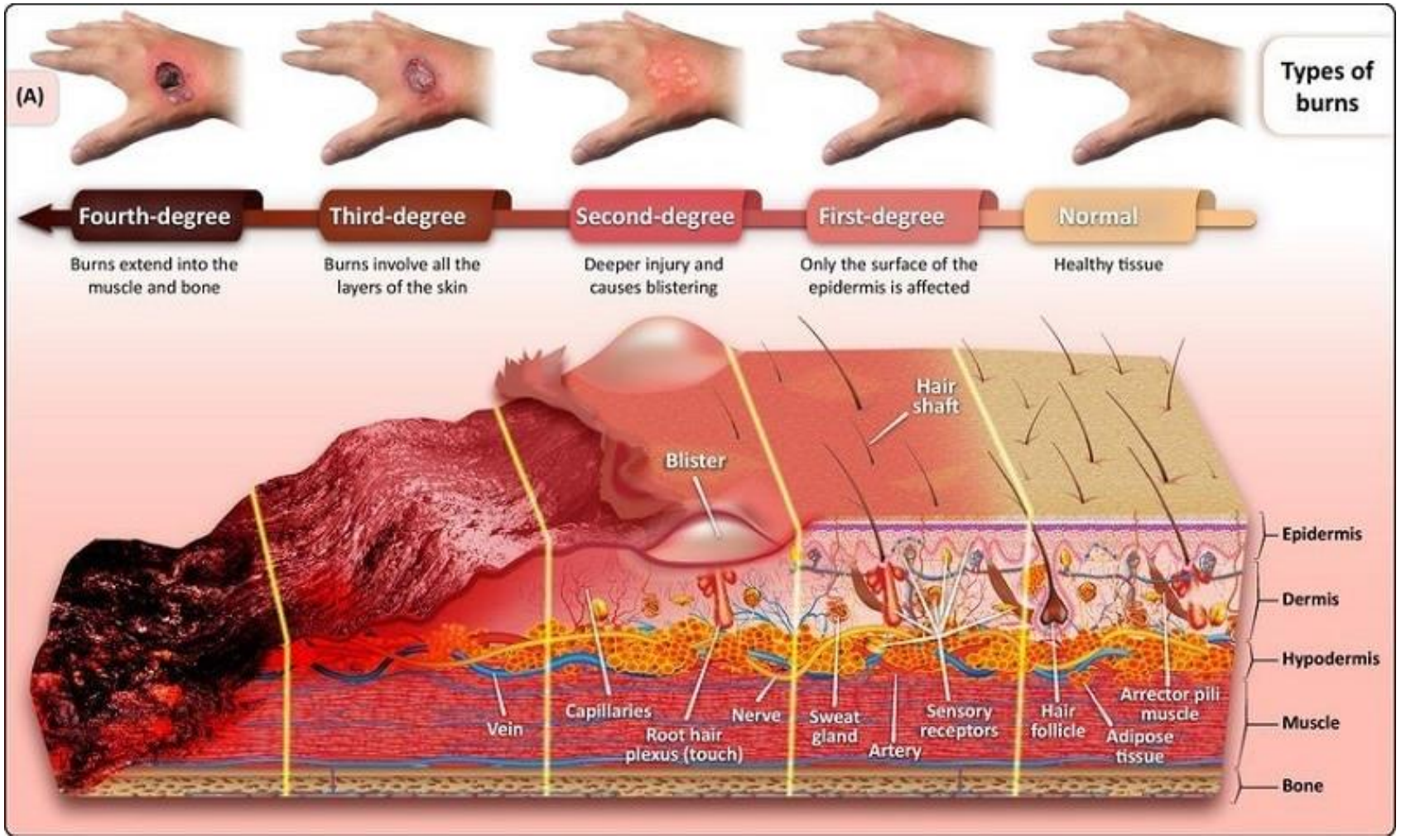
Burns

- Healing occurred in 3 stages:
  - congestion
  - inflammation
  - suppuration

- Morbidity and mortality were related to degree, type, surface area, hypoxia, asphyxia, and 2^{o} pneumonia.

- Healed burns resulting in contracture were treated with attempted reconstructive surgery.

Burns
(Healing Stages)



Burns

- WW1 burn care was developed from burn treatment in the 1800s.
- WW1 surgeons had a limited understanding of the pathophysiology of burns and their complications like hypothermia and shock.
- Physicians stressed antisepsis and dressings, and later on, basic reconstructive surgery, and skin grafting.

John Singer Sargent, 1918

WWI POISON GAS WARFARE

Poison Gas Warfare

- WW1 was the first conflict to use deadly gases released by drift gas.
- The effects of drift gas released into wind currents and carried into trenches were unpredictable.
- Shifting wind currents resulted in both friend and foe exposure.

Poison Gas Warfare

Types

- Lachrymators: “Tear gas”, intense eye irritation
- Sternutators: “Sneeze gas”, nasal irritation
- Suffocants: Attacked and corrupted the lungs
  - Chlorine
  - Phosgene
- Vesicants: Blistered skin and respiratory tract
  - Mustard
  - Lewisite

Poison Gas Warfare

- Shells delivered aerosolized poison gases (chlorine, phosgene, mustard) via explosion.
- A large majority of soldiers exposed to gas survived but suffered painful residual effects of damaged lungs.
- Gas masks and preventive education helped decrease pulmonary exposure.

Poison Gas Warfare

- Cutaneous contact with gas fumes caused blisters, sores, & other health problems.

- To restrict exposure to residual gas on clothing, decontamination efforts of bathing & changing clothes immediately were implemented.

Poison Gas Warfare

- All of the European powers had signed the Hague Declaration in 1899, vowing never to use poison gas in artillery shells or other projectiles.
- The Hague Convention of 1907 again forbade the use of poison weapons.
- Once Germany used gas on the battlefield, in 1915, all other armies began to use it.

Poison Gas Warfare

- First introduced on April 22, 1915, its use quickly became commonplace by all of the combatants.
- Poison gas was 1 of the defining symbols of WWI.
- By 1917, 1/3 of all artillery shells contained gas.
- So, about 1/3 of all AEF casualties were from gas.

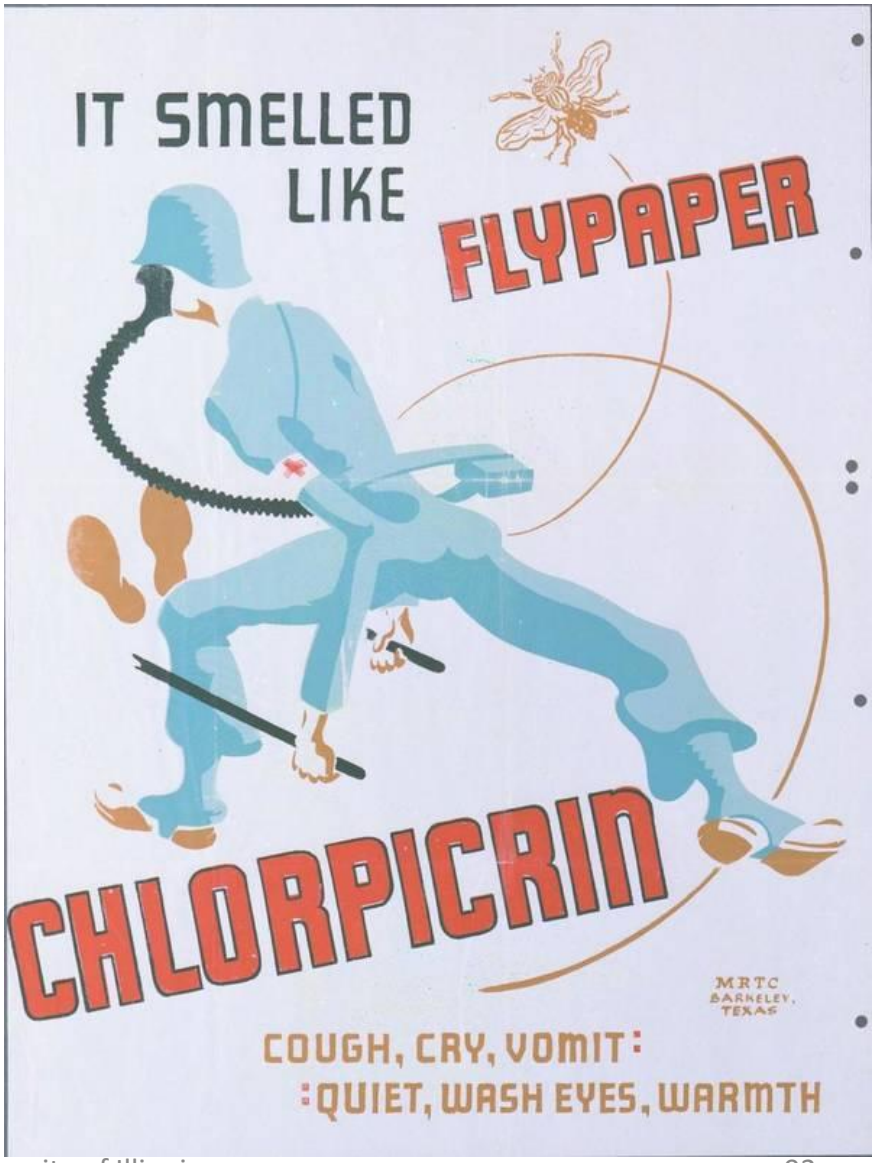
Poison Gas

- Germans 1st used half-buried tanks of gas.
- When the wind was blowing away from their own lines, Germans opened the valves and allowed the gas to billow towards the Allies.
- There were 4K casualties with 1K deaths.

- Chlorine gas, when it contacts tissue, dissolves in water to form hydrochloric acid.
- Chlorine can also cause severe damage to eyes and exposed mucous membranes.
- Its primary target is the lung, and death usually results from inhalation injury.

Chloropicrin

- Lachrymosing agent
- Not very toxic
- Induced vomiting
- Soldier would take off mask and get exposed to other more toxic gases.

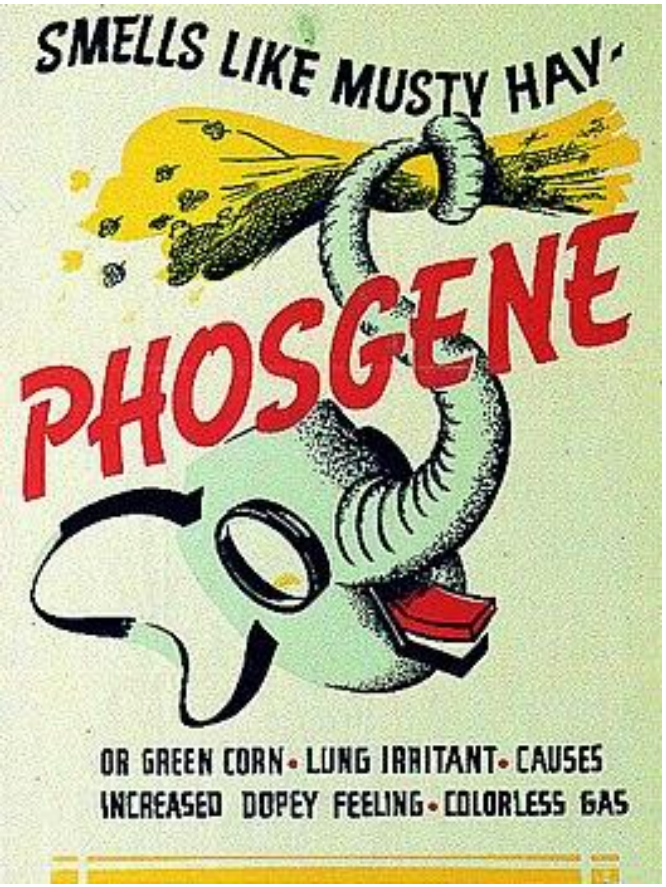


Warning to soldiers about removing masks!!!

Nitrogen Mustard Gas

- Introduced in July 1917 by the Germans, it eventually caused more chemical casualties than all the rest put together.
- It is a vesicant which causes severe blistering of the skin, and attacks the mucous membranes of the eyes, nose, mouth and respiratory tract.
- It is especially dangerous to the eyes; while most patients recovered their vision, a significant number remained permanently blind.

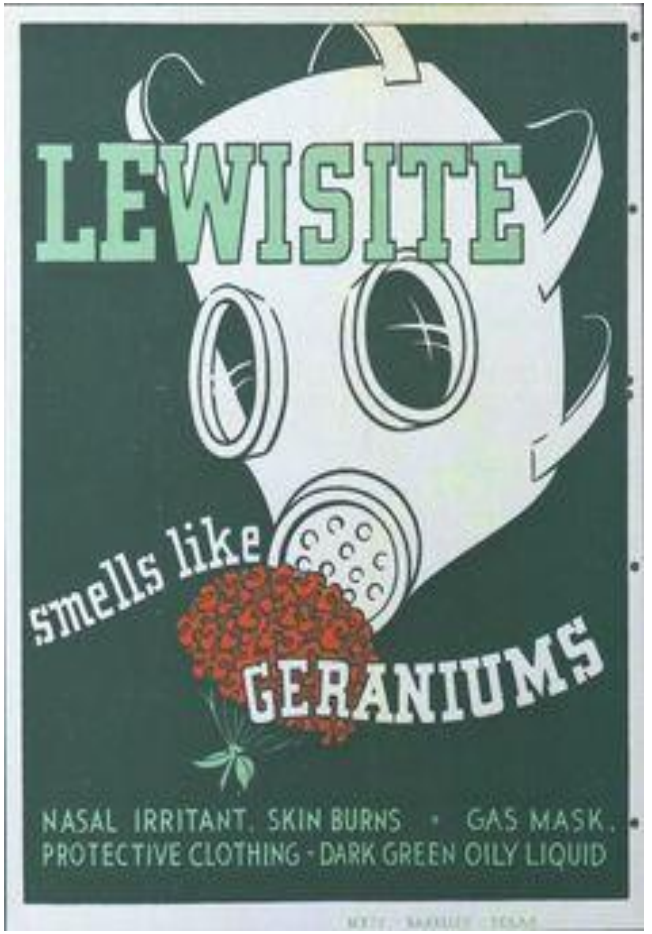
Phosgene



- Introduced in late 1915, it was used extensively, often mixed with chlorine.
- The British called the combination “White Star”, after the symbol painted on artillery shells filled with it.
- Phosgene may not show major symptoms for 48 hours, and then causes pulmonary and heart failures.
- Death is usually from lung failure.

Lewisite

- *Lewisite*, developed late in WWI, never used.
- Vesicant, with more immediate action than mustard, it can enter the body through the skin to do further internal damage.
- Nowadays, newer poison gases, such as the organophosphate nerve agents sarin, soman, tabun, and VX, are much more potent.
- They are more lethal and more rapidly-acting than those used in World War I, and cause death from respiratory failure and pulmonary edema.



British Anti-*Lewisite*
(BAL, Dimercaprol)

- During World War II, BAL minimized the risk to the Allied infantry of injury or death from *Lewisite*, a very potent arsenic-based chemical warfare agent.

- Once developed, BAL revolutionized the treatment of heavy metal poisonings like arsenic, mercury, gold, and lead.

- Today, BAL might again become prominent should terrorists or governments use *Lewisite* against civilians or military forces.

Poison Gas Warfare

Treatment

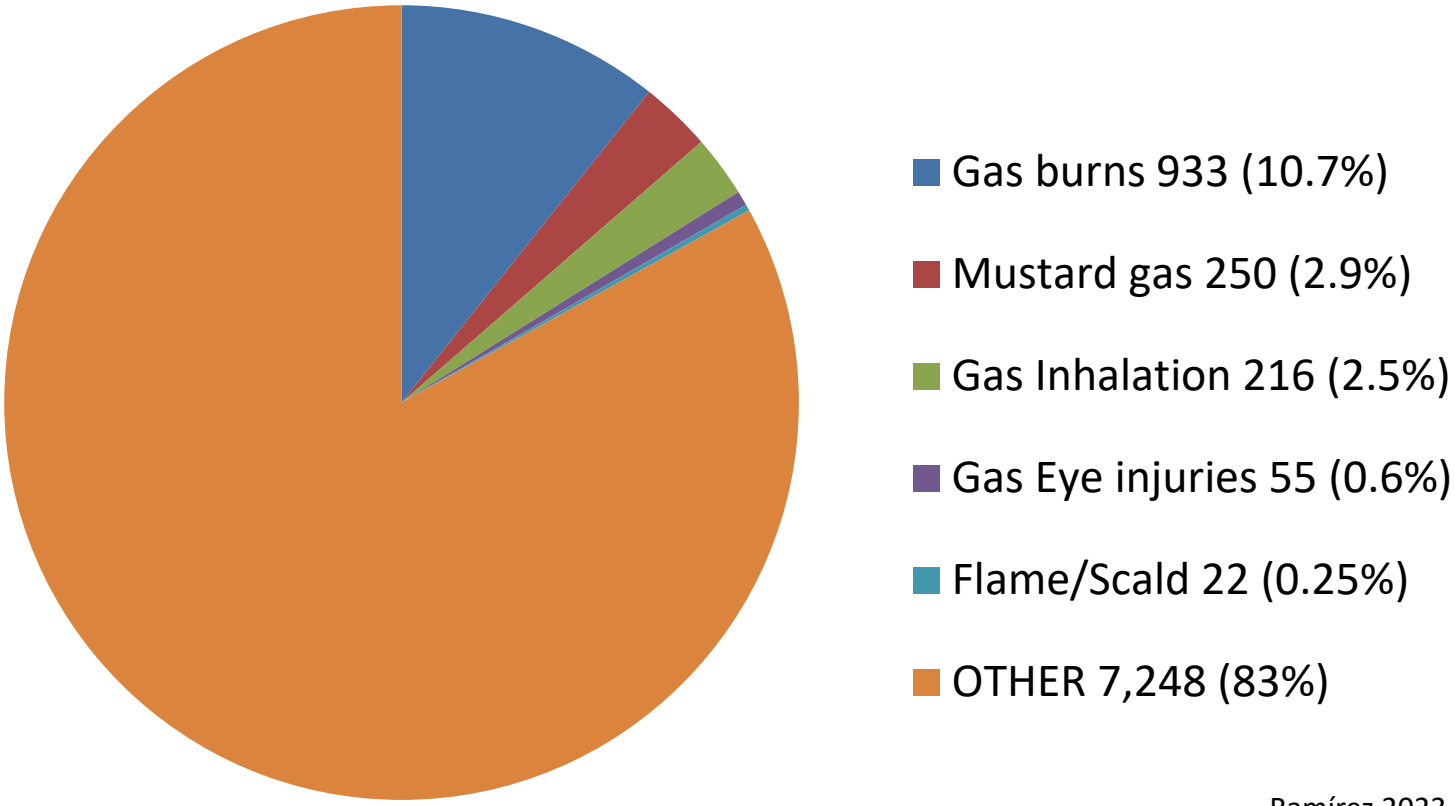
- Treatment was limited to supportive care.
- All the medical services could do for chlorine and phosgene gas victims was to put patients on bed rest, and hope that severe symptoms didn't emerge.
- Mustard gas was another story:
  - The soldier had to be stripped, and completely washed.
  - The eyes had to be washed out to avoid late damage.
  - It acted more slowly, but it also attacked the lungs, causing refractory pulmonary edema in the lower respiratory tract.

Poison Gas Warfare

- AEF had about 1500 deaths from poison gas, out of 52K battlefield deaths.
- But the **total** number of AEF gas injuries was about 90K to 100K, or 30% of all casualties.
- Overall, there were 1.3M gas casualties during the war, and about 90K deaths.
- About half of the deaths were in the Russian army, which was very slow in providing protective gear to its soldiers.

WWI Injuries

Admission records from Base Hospital 28, Limoges, France, showed that, in a 9-month period in 1918, 8,724 patients were treated:



Ramírez 2023

WWI and PLASTIC SURGERY

WWI and Plastic Surgery

- Soldiers during WWI suffered facial wounds on the Western Front that had never been seen before in warfare.

- Hailstorms of bullets, exploding metal shells and shrapnel tore off the flesh and ripped off the faces of men who dared to peek out of their trenches or attempted to dodge machine gun fire.

- Soldiers were not killed immediately, those who survived could be horribly disfigured.

WWI and Plastic Surgery

- Plastic surgery is surgery of reconstruction; its goal is to regain appropriate function as well as achieving a satisfactory appearance.

- Beside the needless slaughter of millions, there were also '*les mutillés*', the enormous numbers of mutilated war-wounded.

- Amongst the many war injuries, there were devastating facial injuries caused not only from machine gun bullets but also by shrapnel from exploding shell cases, which ripped faces apart.

WWI and Plastic Surgery

- In a moment, a soldier would become a person who could not speak, could not eat, and could not easily breathe.
- They were significantly disfigured, and struggling with the inevitable psychological burdens of every other soldier.
- Injuries like these had not been experienced before, as in prior wars soldiers would not have survived.
- There was no guidance for surgeons to manage them.

WWI and Plastic Surgery

Harold Delf Gilles

- Harold Gillies, (later Sir Harold) a young surgeon, initially sent to Belgium, became intrigued with these injuries and busied himself trying to solve their issues.
- He was sent back to Britain with instructions to set up a hospital specifically for the treatment of facial injuries.
- His initial hospital became unable to manage the vast numbers of patients returning from the front.
- He supervised the construction of Queen Mary's Hospital, at Sidcup, opened in 1917, with 320 beds but increased to 2,000 by the end of the war.

WWI and Plastic Surgery

- Sidcup became the focus for major facial trauma, and over 5,000 patients were treated there.

- It was an international service, with staff from Great Britain, Canada, Australia and New Zealand working in parallel.

- Some patients had irretrievable injuries and some died, but the final results on many of the patients were remarkable, since nearly all the wounds were infected, and there were no antibiotics.

WWI and Plastic Surgery

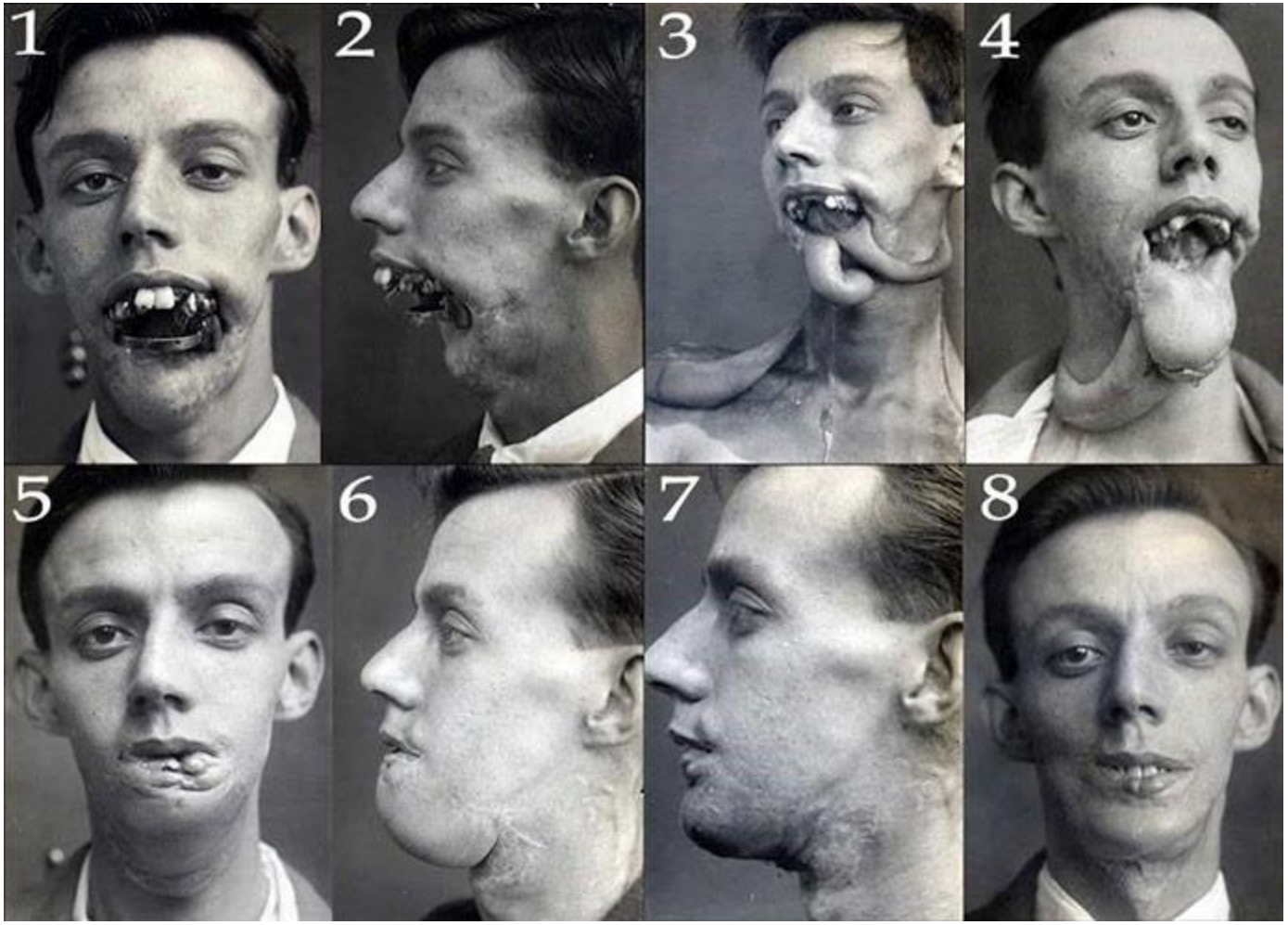
- Gilles was joined by William Kelsey-Fry, both a physician and a dentist.
- Together they created a team which could jointly treat both bony, dental, and soft tissue elements.
- This progressed to develop the new specialty of maxillofacial surgery.

William Kelsey-Fry

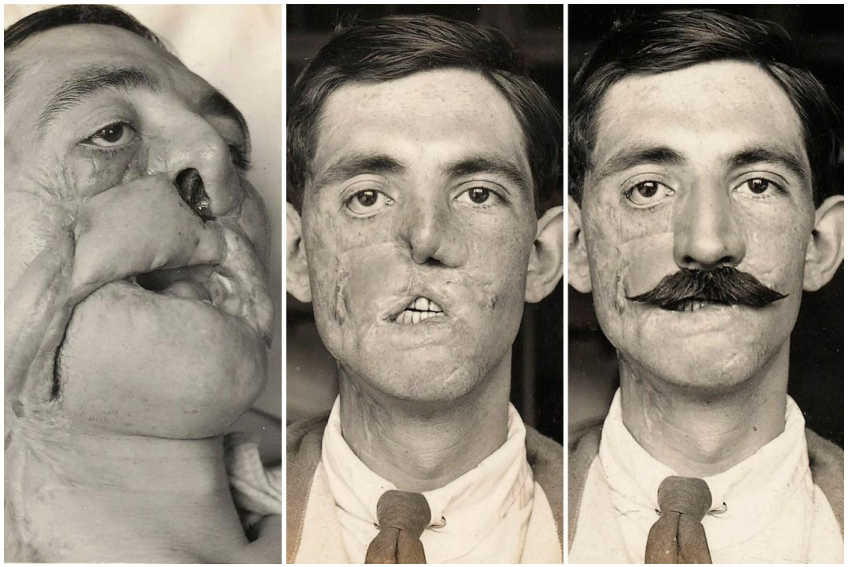
WWI and Plastic Surgery

- For a large lower face injury, Gilles wanted to raise a flap of skin from patient's chest to repair the wound.
- During the operation, he noticed that the edges of the pedicle flaps curled in on themselves under tension.
- He decided to sew them into a tube and found that the risk of infection was reduced and the blood supply was much better.
- Once the tubed pedicle became firmly attached near the injury, it could be cut away from the donor site, opened and spread out to graft the required area.

Birth of Plastic Surgery



Birth of Plastic Surgery



Walter
1917

WWI and Plastic Surgery

- Facial injuries were not easily treated on the front line.
- Surgeons would stitch together a jagged wound without worrying about the amount of tissue that had been lost.
- As the scars healed, and the flesh tightened, they pulled the face into a hideous grimace.

WWI and Plastic Surgery

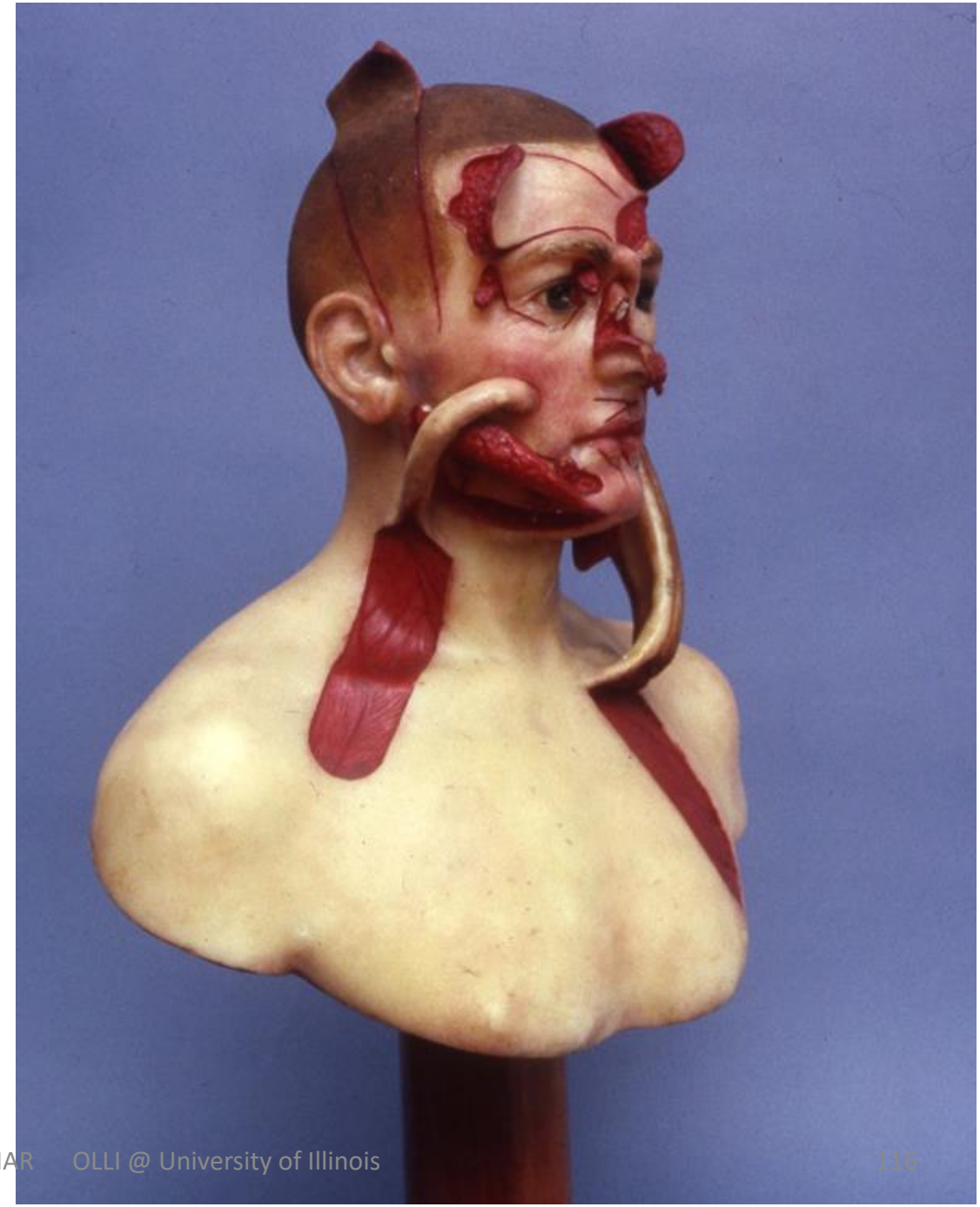
- Gilles ignored professional boundaries by encouraging the collaboration of surgeons, dentists, technicians and illustrators in what is probably the first multidisciplinary medical service.

- This approach included the patient as part of the team, unique for the period.

WWI and Plastic Surgery

- Jaw injuries could leave men unable to eat or drink.
- Some men had to be nursed sitting up to stop them from suffocating when they lay down.
- Others were blinded or left with a gaping hole where their nose used to be.

1917 wax teaching model for tubed flap technique.



WWI and Plastic Surgery

- Gillies' work continued after the war for many years.
- He continued to develop his ideas, writing the first textbook on the subject in 1920 to record his approach and the methods devised at Sidcup.
- He subsequently directed the management of casualties in WW2, and was the founder of the British Association of Plastic Surgery in 1946.

Next Week

- Session 1: Ancient history, Rome, Greece.
- Session 2: Middle Ages, weapons & injuries.
- Session 3: US Revolutionary & Civil Wars.
- Session 4: World War I.
- Session 5: World War II.
- Session 6: Korea, Vietnam.
- Session 7: 20th & 21st Century Regional wars.
- Session 8: Peek into future, Nuclear War?