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A HISTORICAL OVERVIEW OF BATTLEFIELD WOUNDED CARE IN THE LIGHT OF TODAY'S MODERN TOOLS

A HARCTÉRI SEBESÜLTELLÁTÁS TÖRTÉNETI ÁTTEKINTÉSE NAPJAINK MODERN ESZKÖZEINEK TÜKRÉBEN

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Abstract

Every major military conflict has contributed to the advancement of wound treatment techniques and equipment. From the primitive surgical interventions of ancient times to the advanced medical procedures used in modern warfare, numerous innovations have emerged that have improved the survival chances of the wounded. In the modern era, technological innovations have revolutionized casualty care. Portable ultrasound and CT devices have made it possible to diagnose injuries quickly and accurately, even under battlefield conditions. The use of robotics and telemedicine has further increased the effectiveness of treatments. Innovative tools aimed at reducing blood loss and stabilizing injuries have significantly improved survival rates. This study, following these lines of development, presents how lessons from the past have contributed to today's technological innovations, and how future advancements may impact military medical care.

Keywords

phased battlefield casualty care, portable diagnostic devices, non-invasive therapies, LLLT, ultrasound therapy, electrotherapy

Absztrakt

Minden jelentős katonai konfliktus hozzájárult a sebellátási technikák és eszközök fejlődéséhez. Az ókori primitív sebészi beavatkozásoktól a legújabb kori háborúk során használt fejlett orvosi eljárásokig számos innováció született, amelyek a sebesültek túlélési esélyeit javították. A modern korban a technológiai újítások forradalmasították a sebesültellátást. A hordozható ultrahang- és CT-berendezések lehetővé tették a sérülések gyors és pontos diagnosztizálását, még harctéri körülmények között is. A robotika és a telemedicina alkalmazása tovább növelte a kezelések hatékonyságát. A vérveszteség csökkentésére és a sérülések stabilizálására használt szorító kötések és vérzéscsillapító szerek jelentős mértékben javították a túlélési arányt. A jelen tanulmány ezen fejlődési vonalak mentén haladva mutatja be, hogy a múlt tanulságai hogyan járultak hozzá a jelenkor technológiai újításaihoz, illetve a jövőbeli fejlesztések milyen hatást gyakorolhatnak a katonai orvosi ellátásra.

Kulcsszavak

szakaszos harctéri sebesültellátás, hordozható diagnosztikai eszközök, nem invazív terápiák, lágylézer terápia, ultrahang terápia, elektroterápia

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INTRODUCTION

Battlefield casualty care has played a vital role in the success of military operations for centuries. In modern warfare, the immediate treatment of injuries and the rapid evacuation of the wounded have a direct impact on the efficiency and morale of military units. Providing timely and context-appropriate medical care significantly increases survival rates, reduces the number of battlefield fatalities, and improves long-term health outcomes. The development of battlefield medical care has been a major military and scientific challenge in every significant war. Innovations such as the use of disinfectants, anaesthesia, portable medical equipment, and basic first aid have brought fundamental changes. On today's battlefield, telemedicine, drone-based transport, and AI-powered diagnostic systems have further revolutionized casualty care, enabling military medical personnel to treat the wounded more effectively.

The aim of the present research is to provide an overview of the historical development of battlefield casualty care and to demonstrate how modern technological advances have improved the survival chances of the injured and the overall efficiency of medical treatment. The study explores how historical contexts interact with modern medical technologies and how past experiences influence current practices. It also analyses to what extent technological innovations, such as portable therapeutic devices, have transformed casualty care and impacted soldiers' chances of survival. This topic is particularly relevant today, as modern warfare presents new challenges to medical practice. Asymmetric conflicts, the evolution of military technology, and varying battlefield conditions demand new and unique solutions. Moreover, developments in military medical science may also benefit civilian disaster response and emergency medical services.

MATERIALS AND METHODS

For the writing of this publication, a secondary research method was applied. This involved systematically organizing and reanalysing existing data, including relevant academic literature, publications, records, and online journals related to the topic. Throughout the research process, particular attention was paid to ensuring that the sources used were verifiable, reliable, and accurate. The secondary literature review was concluded on November 5, 2024, at which time all downloaded materials were accessible online.

THE HISTORICAL DEVELOPMENT OF BATTLEFIELD CASUALTY CARE

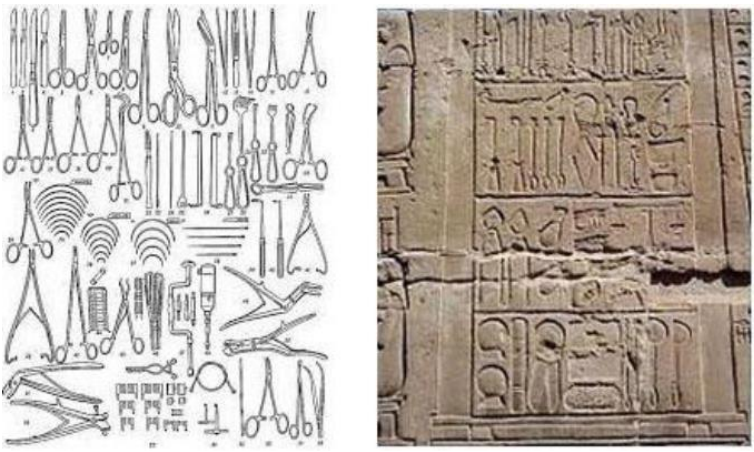
The treatment of injuries sustained during combat has a history spanning thousands of years, with the methods used in each era reflecting the level of technological advancement in weaponry, transportation capabilities, the effectiveness of disinfection procedures, and the development of surgical techniques.

Wound Treatment in Antiquity

The ancient Egyptians employed wound treatment methods that can be considered precursors to modern disinfection principles. To clean wounds, they used wine and seawater. The alcohol in wine aided in cleansing the wound, while the salt content of seawater accelerated wound contraction. Based on their observations, they realized that purulent wounds needed to be drained. Rather than closing discharging wounds, they treated them with a mixture of honey, fat, and plant fibres. As shown in *Figure 1*, wounds were covered with linen or woollen fabrics, which helped prevent contamination and reduced the risk of infection. Egyptian physicians and priests developed their healing techniques based on practical experience and documented them in writing in the collection known as the *Ebers Papyrus*, which served as the primary source of medical knowledge of the time. [1]

1.Figure: Ancient Egyptian bandage [1, 27.p.]

According to ancient papyri, the Egyptians between 3000 and 2000 BCE were familiar with approximately 700 medicinal substances, and by 1500 BCE this number had risen to 876. Of the 349 drugs used between 1850 and 1350 BCE, around 70% were still in use at the end of the 20th century, and several are still being manufactured today. [1]



2. Figure: Depiction of surgical instruments on the wall of the temple at Kom Ombo [1, 28.o.]

Depictions from ancient Egypt also confirm the presence of surgical practices. As shown in *Figure 2*, a stone carving on the wall of the temple in Kom Ombo illustrates tools that bear a remarkable resemblance to modern surgical instruments. [1]

In ancient Egypt, healing was closely intertwined with religion. Their medical practices often reflected the constant struggle between demons and gods, which was a central theme in their worldview. [1]

3. Figure: Red figure aryball 480-470 BC [3, Figure 1.]

The earliest known reference to wound treatment in ancient Greece is found in Homer's Iliad, written around 700 BCE, which recounts the Trojan War that took place roughly 500 years earlier. In addition to traditional long-range weapons like the bow, the opposing armies engaged in close combat using spears (dory), swords (xiphos), and sabers (kopis), often inflicting severe injuries. [2]

In Book IV of the Iliad, a surgeon named Machaon extracted an arrow from the abdomen of the Spartan king Menelaus, sucked out the poison from the wound, and applied medicinal ointments. In Book XI, Achilles' friend Patroclus cut out an arrow from the thigh of Eurypylus, king of Thessaly, washed the blood with warm water, and applied healing balms. One of the longest-standing principles of wound treatment, which remained influential for centuries, comes from the works of Hippocrates (ca. 460–377 BCE). His writings introduced key innovations such as chest tubes for draining bodily fluids, external fixation for properly aligning broken bones, and important observations on head injuries. Hippocrates believed that wounds should be kept dry, irrigated only with clean water or wine, and that suppuration (pus formation) was a natural part of healing, helping to expel "corrupted" blood. [2]

Figure 3 features a small red-figure vase dated around 480–470 BCE, depicting outpatient care in ancient Greece. In image "A," a physician is treating a patient. The young doctor is making an incision in the right arm vein of a standing man using a lance. The man leans on a stick and watches the procedure with a frightened expression. [3]

Casualty Care in Medieval Europe and Hungary

4. Figure: Medieval barber surgeon during surgery [5]

During the Middle Ages, physicians held a higher social status than surgeons, which meant that scientific writings on wound treatment were scarce. Nevertheless, the surgeon Guy de Chauliac (1298–1368) recorded five foundational principles of wound care: the prompt removal of foreign objects, the reunification of damaged tissues, the preservation of tissue continuity, the conservation of bodily materials, and the prevention of complications. Projectiles from firearms caused severe tissue destruction and, passing through the heavily contaminated clothing of soldiers, introduced pathogens into wounds, leading to serious infections. Since contemporary healers were unaware of bacteria, they poured boiling oil into wounds to destroy what they assumed were poisons from black powder. However, during the Siege of Turin in 1536, the French surgeon Ambroise Paré achieved remarkable anti-inflammatory success using an alternative ointment made of egg yolk, rose oil, and turpentine in the absence of hot oil. [2]

In Hungary, battlefield casualty care remained an unresolved issue for centuries. Historical records credit Tamás Esze with being the first to articulate the need for treating injured and disabled soldiers on the battlefield and for employing military physicians. In Europe and Hungary, organized care for war invalids began with the French in 1674, followed by the Habsburgs in 1692. Prior to this, military science made no mention of tactics for mass casualty care, logistics, or sustained medical support. Though these aspects were absent from theoretical officer training, their importance became immediately evident in battlefield practice. During campaigns or sieges, barber-surgeons, such as those shown working in *Figure 4*, were contracted to serve the army for a specified duration, number, and salary. These barber-surgeons provided their own surgical instruments, medicines, and dressings, which they brought to the battlefield. At the time, the roles and duties of barbers and surgeons were still distinct, but as anatomical knowledge advanced, surgery became linked to internal medicine. With the subsequent boom in medical education and the constant state of warfare, both technical and mechanical development accelerated. As previously mentioned, Ambroise Paré (1510–1590), serving as a military surgeon, designed functional limb prostheses and palatal replacements made from precious metals. By the 17th century, surgical advances were largely driven by military medicine, especially in the treatment of burns and gunshot wounds. [4]

Innovations of the Great Wars

5. Figure: Minié projectile [6]

During the American Civil War, the Minié ball, which emerged in the 1850s and is shown in *Figure 5*, caused such devastating injuries that abdominal and thoracic gunshot wounds had a mortality rate of 87%. [2]

The nature of a gunshot wound is influenced by the characteristics of the projectile, the direction of the shot, and the shooting distance. Anatomically, a gunshot wound is divided into three parts: the entry wound, often featuring burn marks from close-range shots; the bullet track, the internal path taken by the projectile; and the exit wound, which may not always be present. Determining the bullet track helps identify internal damage, locate the lodged projectile, and facilitate its removal. [7]

At the start of the Civil War, gunshot wounds were treated primarily with cauterization and tourniquets. Over time, practical experience led to the widespread use of pressure dressings, which significantly reduced primary haemorrhage. However, due to secondary bleeding occurring on the third or fourth day, the mortality rate remained above 62%. [2]

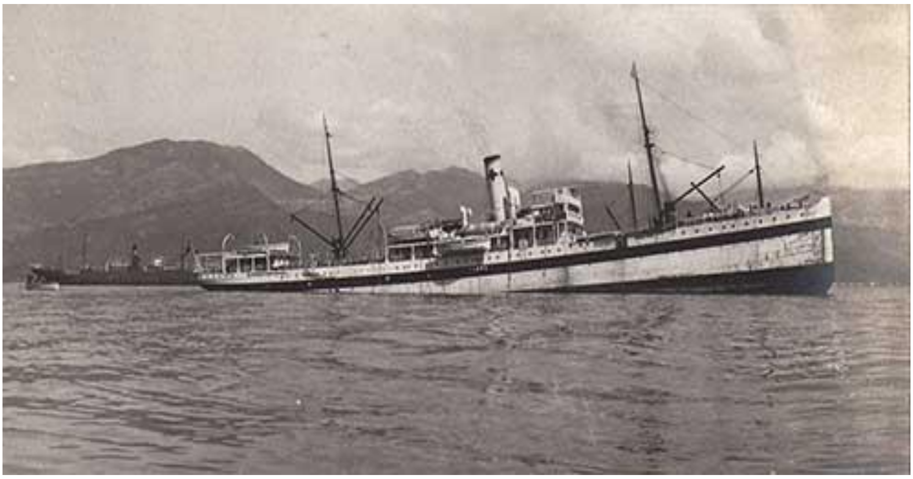
6. Figure: Wounded people waiting to be loaded into wagons [8]

In World War I, femoral fractures had a mortality rate exceeding 80%, which was reduced to 20% through immediate external splinting and immobilization. Medical personnel were trained to perform procedures blindfolded, enabling treatment in the dark or low-visibility conditions. Surgeons also discovered the benefits of delayed wound closure; they would take swabs from the wound and base the decision to close it on the presence of pathogens. Triage systems were used to classify the wounded based on injury severity. [2] As seen in *Figure 6*, severely wounded soldiers were gathered and evacuated by road, rail, or ship to military hospitals farther from the combat zone.

In the Austro-Hungarian Empire, medical trains and hospital ships were introduced to speed up treatment. Hospital trains were designated for the severely injured, while transport carriages, such as those in *Figure 7*, were used for lighter cases. By March 1915, 128 mobile medical rail units were in operation, increasing to 151 by the end of the war in 1918. These units had a combined capacity of 39,334 beds, and nearly 8 million wounded soldiers were transported during the conflict. [9]

In the First World War, the three best-known hospital ships of the Austro-Hungarian Monarchy were the 3199-ton Elektra, launched in 1884 and accommodating 355 wounded, the 879-ton Metkovich, commissioned in 1893, capable of caring for 135 wounded, and the 2836-ton steamers Tirol, completed in 1901, which provided accommodation for 300 wounded, shown in *Figure 8*. In addition to the naval staff doctor serving as military commander, the ships were staffed by a field chaplain, a naval officer, three non-commissioned officers and 6-12 nurses. [10]

7. Figure: Medical train at Villach, 1916 [9]



8. Figure: The Tirol hospital ship that hit a mine [10]

In World War II, American surgeon Edward D. Churchill (1895–1972) developed a wound closure approach based on the wound's appearance. In 1944 in northern Italy, he closed 25,000 soft tissue wounds where tissue appeared healthy and free of debris or oedema, achieving a 5% mortality rate. [2]

During the Korean War (1950–1953), frontline surgeons used compression dressings to stop bleeding and resorted to tourniquets only when necessary. If immediate evacuation was impossible, they began antibiotic therapy and blood transfusions on site. [2]

In the Vietnam War, American forces encountered complex, multiple injuries caused by AK-47s, SKS rifles, and explosive traps used by North Vietnamese and Viet Cong troops. Due to combat conditions, it was rare for the wounded to receive surgical treatment within 1–2 hours; the average evacuation time was 4–6 hours. In such cases, patients were given Ringer's lactate to counter blood loss and began antibiotic therapy. Wounds were cleaned, irrigated, and dressed. In field hospitals, vascular and orthopaedic surgeons treated the injured. Fractures were managed through bone alignment, traction, or plastering. [2]

In Iraq and Afghanistan, suicide bombers and improvised explosive devices (IEDs) changed the nature of warfare. These caused extensive and complex tissue damage, often necessitating limb amputations. In many cases, resuscitation began on-site and continued during aerial or ground evacuation. [2]

Phased Battlefield Casualty Care

According to the principle of phased care, wounded soldiers on the battlefield are treated in stages, based on the severity and location of their injuries. The first phase of care is battlefield first aid, provided either by the injured soldier themselves (self-aid) or by fellow soldiers (buddy aid) using a standardized personal first aid kit. This kit typically includes sterile dressings, bandages, pressure dressings, a Velcro tourniquet, adhesive bandages, tape, nasal and mouth masks, scissors, tweezers, and a user manual. [11]

9. Figure: The tools of the field surgeon [12]

The second level of care - referred to as advanced buddy aid - is provided at a relatively safe area near the frontline. Here, a better-trained soldier equipped with more advanced medical tools stabilizes the wounded before they are transported to higher-level treatment facilities. [11] *Figure 9* shows the tools used by a field surgeon at this stage.

Beyond basic first aid, treatment continues at increasingly advanced echelons of care, defined as:

- ROLE 1: Medical aid post
- ROLE 2: First field hospital
- ROLE 3: Civilian or military hospital in the operational area
- ROLE 4: Specialized hospital in the home country or rear area [11]

The Role of Modern Rehabilitation Devices in Phased Battlefield Casualty Care

The primary objective of battlefield casualty care is the rapid rehabilitation of injured soldiers, so they can return to duty and continue combat operations. [11] Following traditional wound dressing or surgical treatment, electrotherapy, low-level laser therapy (LLLT), and ultrasound therapy are recommended rehabilitation methods across all echelons of care of ROLE 1 through ROLE 4.

Electrotherapy is a therapeutic technique that uses electric currents to treat various diseases, relieve pain and injuries, and regenerate tissue. Widely used in physiotherapy and rehabilitation, this method enhances cellular function through controlled electrical impulses that stimulate healing processes. [13] *Figure 10* depicts a modern electrotherapy device.

Electrotherapy supports pain relief, nerve and muscle stimulation, reduced inflammation, and improved blood circulation. Its non-invasive nature makes it an appealing alternative to drug therapy, reducing side effects and accelerating recovery. The microvolt (μV) and millivolt (mV) ranges used ensure gentle, regulated effects on cells, minimizing the risk of tissue damage. [13]

10. Figure: PhySys SD electrotherapy device (author's own photo)

This therapy enhances cell metabolism, oxygen uptake, and nutrient absorption, while optimizing membrane potential and promoting neural communication. Controlled muscle stimulation also supports rehabilitation of weakened or injured muscles, improving mobility, tissue regeneration, and preventing muscle atrophy due to inactivity. [13]

11. Figure: Modern soft laser therapy device [author's own photo]

LLLT, or soft laser therapy, is a low-energy laser treatment used to stimulate cellular regeneration, relieve pain, and reduce inflammation in damaged tissues. During treatment, low-intensity laser light penetrates the tissue, energizing cells and supporting healing processes. [14] *Figure 11* depicts a modern electrotherapy device.

Commonly applied for musculoskeletal issues, inflammation, and pain, LLLT uses light wavelengths of 810 nm and 980 nm, which effectively reach deep tissue layers. The 810 nm wavelength penetrates muscles and ligaments, reducing inflammation and pain, while 980 nm light stimulates blood flow, enhancing regeneration and nutrient delivery. Benefits of LLLT include faster tissue healing, pain reduction, and improved joint mobility. It enhances cell metabolism and oxygen intake, which helps restore function to injured areas. Because it naturally supports the body's healing processes, it contributes to both symptomatic relief and long-term recovery. [14]

12. Figure: Modern ultrasound therapy device [author's own photo]

Ultrasound began to be used in medicine in 1938 and has since been used in many medical fields, including diagnostic, surgical and therapeutic purposes. It is a form of medical treatment in which human tissues are stimulated with high-frequency sound waves, which promotes healing processes and reduces pain. Its purpose is to stimulate blood circulation and metabolism by penetrating into the deeper layers of tissues, which contributes to cell regeneration, reducing inflammation and relaxing muscles. *Figure 12* shows a modern ultrasound therapy device. Ultrasound waves with a frequency of 0.8 to 2.4 MHz are particularly suitable for penetrating deep into muscle and joint tissues. The lower frequency waves (0.8 MHz) penetrate deeper layers, so they exert their healing effect on the deep areas of the joints and muscles, while the higher frequencies (2.4 MHz) affect the surface tissues. During therapy, sound waves create microscopic massage movements between cells, which increase the oxygen supply and nutrient uptake of cells and help to remove waste products accumulated there. The heat effect created by ultrasound relaxes the muscles, reduces pain and increases the flexibility of the affected areas. [13]

In the case of ultrasound treatments, a triple energy transformation occurs: the electrical energy in the ultrasound hand head is converted into mechanical energy, and then it becomes thermal energy when it enters the human tissue. With the help of the artificially produced polycrystalline ceramic material of the ultrasonic heads, the treatment unit converts electrical energy into mechanical energy. The energy emitted is a longitudinal mechanical wave, where the alternating condensation and rarefaction of the particles of matter in the direction of sound propagation occurs. When two different tissues reach the border, some of the ultrasound waves are reflected and only the other part penetrates the new medium, this is called interface reflection. At the border of muscle and bone tissue, the degree of reflection can reach 30%. The effect induced by ultrasound irradiation is based on the absorption capacity of the tissues. As a result of absorption, the ultrasonic intensity used on the tissue surface, measured in W/cm^2, decreases exponentially with depth in the direction of propagation. As the depth decreases, the frequency values also change. In human tissues, ultrasound acts both superficially and deeply. It exerts its beneficial biological effects at a depth of 8 cm, the half-life layer is 4 cm. Due to the absorptions, the intensity of radiation is reduced by half between 4 and 8 cm. Compared to the energy absorption capacity of muscle tissue, fat tissue absorbs half as much, ligaments and tendon tissue absorb four times as much, and bone tissue absorbs ten times as much energy. The more energy a tissue absorbs, the more it heats up. The order of tissue warming: bones, tendons and ligaments heat up the most, followed by nerves, muscles, skin, internal organs and least of all adipose tissue. [13]

In the phased battlefield casualty care system, electrotherapy, low-level laser therapy, and ultrasound therapy are most effectively used at the echelon of care highlighted in yellow in Table 1.

Level	**PHASED BATTLEFIELD CASUALTY CARE LEVELS**			**Required competency**
	Designation / Location		**Content**	
	Battlefield	**Battlefield First Aid**	first aid Self-aid or buddy aid using a standardized first aid kit (sterile dressings, bandages, pressure dressing, tourniquet, etc.)	
	Battlefield in a safe location further away from the forward edge of the battle-area	**first special help**	first aid medically trained personnel using basic medical tools	
	theatre of operations further away from the forward edge of the battle-area first medical aid station	**ROLE 1**	specialist (surgeon, orthopaedist)	
	theatre of operations, further away from the forward edge of the battle-area first field hospital	**ROLE 2**	Emergency traumatology care Modular healthcare facility	
	theatre of operations, further away from the forward edge of the battle-area civil- or military hospital	**ROLE 3**	triage and emergency care, outpatient care, inpatient care, pharmacy, clinical laboratory, blood bank, radiology, physiotherapy, medical logistics, operative dental care (emergency and basic), oral and maxillofacial surgery, nutritional care, patient administration services.	
	hospital in the hinterland	**ROLE 4**	General hospital care	

Table 1. Phased Battlefield Casualty Care (own compilation based on referenceses [11] and [12])

CONCLUSIONS AND SUMMARY

The use of electrotherapy, low-level laser therapy (LLLT), and ultrasound therapy is well justified in battlefield casualty care, where rapid and effective methods are essential for treating injured soldiers. Due to their tissue-regenerating and anti-inflammatory effects, these modalities support the treatment of injuries such as muscle damage, dislocations, surgical wounds, and oedemas, which are common in combat environments.

Modern therapeutic devices are now available in compact and portable forms, making it feasible to apply these treatments even in field conditions. This significantly contributes to faster and more efficient care for battlefield casualties, which is critical to avoid further complications and ensure that soldiers can return to duty as soon as possible.

As non-invasive treatment options, these therapies often serve as effective alternatives to pharmacological interventions, especially in field settings where access to medications may be limited. The combined use of these three therapeutic methods offers a fast, efficient, and natural-healing-supportive approach, which is particularly advantageous for mobile and field-based medical services.

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