

6-2018

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Repository Citation

Dougherty, Gwendolyn E. (2018) "Avoiding Death Like the Plague: Wound Care in the Roman Army," *#History: A Journal of Student Research*: Vol. 2 , Article 2.

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AVOIDING DEATH LIKE THE PLAGUE: WOUND CARE IN THE ROMAN ARMY

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Roman Imperial dominion was predicated on aggressive, almost incessant war in far-flung places over several centuries. When reflecting on Rome as a warrior culture, history presents Rome's wars as a simply two-sided event: the winners who triumphed and the losers who died. But there is another group that is often neglected, the wounded. The victors lived to fight another day, while the losers either ended up dead or sold into slavery. But what happened to the wounded? How did the Roman army tend to its injured? Rome controlled the world through military might, but could the Romans control or even begin to combat the world of infection and disease, a powerful and unseen enemy?

Before the invention of antibiotics, infection was a serious consequence of improperly treated battle wounds. Visible enemies were not the challenge; swords, clubs, and arrows could provide defense. Aside from the traditional battlefield, armies faced silent enemies that could wipe out a third of their forces overnight. Strong, healthy men were reduced to useless skeletons of soldiers within hours, dead in a few days' time if they were lucky; but most were not. Analysis of the ancient medical literature, such as that produced by the famed Galen of Pergamum (AD 129 – c. 216), indicates little knowledge of bacteria and other microbes by medical authorities. But scholars such as Galen understood that there were changes happening in the body because of wounds that had been inflicted. Having trained under the physicians Satyrus and Pelops, and having been exposed to numerous patients through clinical experiences and practical demonstration, Galen became a leading medical specialist in Rome.¹ It was this expertise that resulted in his understanding of infection and disease, one that made distinctions between the healthy and the ill as a consequence of activity and inactivity. As he himself noted:

For they consider the person in whom no activity of any part is impaired 'to be healthy', but someone in whom one of them is impaired 'to be sick'. Similarly they call someone in whom all the bodily parts are working naturally 'healthy', while someone in whom one of them is impaired is called 'sick'.²

Despite being the leading Roman authority, Galen's medical knowledge, like others in his field, was incomplete. While advanced scientific knowledge was lacking, the protocols of Roman physicians for treating wounds were impressive. Since warfare was an inherent part of Roman culture, death from injuries incurred on the field of battle was a regular experience, and always greeted the living with the same stomach-churning odor that would cling to every inch of their bodies. The ancient historians of Rome, such as Livy (59 BC – AD 17), offered vivid descriptions of such wounds in the infantry combat they describe:

Here and there amidst the slain there started up a gory figure whose wounds had begun to throb with the chill of dawn, and was cut down by his enemies; some were discovered lying there alive, with thighs and tendons slashed, baring their necks and throats and bidding their conquerors drain the remnant of their blood.³

The smell of death was an unmistakable odor when it made its presence known. The stench marked the dead, the living, and the severely infected. Death was not always immediate, however. Those who survived, but had suffered an injury, had another even more difficult battle to win – the one against infection.

Clostridium perfringens (*C. perfringens*), is a living death sentence. It is an invisible enemy more terrifying and destructive than any army the ancient world had seen. An infection by this bacterium marks its victims with fates worse than death itself.⁴ Starting with increased pain and swelling around the injured area – typically in the lower extremities – victims can come down with fever and tachycardia - rapid heart rate - as the infection begins. Within hours, the skin around the site turns pale, and as the battle continues, the skin progresses to dark red, then purple, then black in color, an indication of necrosis – the death of groups of cells in one area. The smell of death emanates from the area as pus drains out of the tissue, leaking from the infected site. What is worse, this is not a localized infection. It originates in tissue killed by an initial traumatic event – puncture wound, arrow, laceration, etc. Once inside, *C. perfringens* releases two devastating toxins that cause platelets to aggregate and eventually kill neighboring cells, allowing the bacterium to continue to spread.⁵

With a reproduction rate of approximately twelve minutes, *C. perfringens* rapidly colonizes wounds, and the host’s body is taken over unbeknownst to the injured. As the infection spreads and more tissue is killed, quite often one option remains – surgical removal of the dead tissue. If left on the body, the results could range from shock, to kidney failure, to death.⁶ The most common surgery option for this type of infection is amputation.

Later such tissue may become liquefied and slough. The margin between healthy and necrotic tissue often advances several inches per hour despite appropriate antibiotic therapy, and radical amputation remains the single best life-saving treatment. Shock and organ failure frequently accompany gas gangrene and when patients become bacteremic, the mortality exceeds 50%.⁷

If victims survive the infection and resulting surgery, they are left to live with scarred and dismembered bodies and the possibility that not all of the infection was removed, causing lifelong agony and fear.

Known today as gas gangrene, or simply gangrene, this highly virulent bacterium has caused many nightmares for healthcare workers and patients. While ancient Romans did not know

that bacteria caused this lethal disease, it was prevalent then as well. As Aulus Cornelius Celsus (c. 25 BC – AD 50) notes:

[S]ometimes there arises what the Greeks call gangrene. The former varieties occur in any part of the body; gangrene in the extremities, that is in the nails, armpits or groins, and generally in aged people or in those of a bad habit of body. The flesh in the wound becomes either black or livid, but dry and shriveled; the skin near it is for the most part occupied by dusky pustules; then the skin around these becomes either pallid or livid, and usually wrinkled, deficient in sensation: farther away from the wound the skin is inflamed...Now...an acute fever arises and great thirst...the stomach begins to be affected: even the breath gets a foul odor. This disorder at its commencement admits of treatment; but when thoroughly established it is incurable, and most patients die in cold sweat.⁸

Thanks to advances in immunology – the study of how the body protects itself – and microbiology – the study of microbes – death sentences handed out by microbes such as *C. perfringens* are no longer guaranteed. While severe cases of gangrene still result in amputations, cases caught early can be treated with an antitoxin, large doses of intravenous penicillin and clindamycin. In certain conditions, oxygen that is applied to the infection site under high pressure may be effective as well.⁹ Advances in medicine and medical technologies have aided patients across the ages – increasing survival rates, decreasing pain levels and increasing overall wellbeing.

While not as advanced as modern treatments, Roman doctors and physicians had their own techniques to combat infections. A common ancient practice by doctors was to use natural products, such as honey, olive oil and vinegar.¹⁰ Efficiency is key to a successful army, and Rome's army was prepared to deal with almost any situation in battle. This preparedness extended all the way to treating their injuries as, “the Roman soldiers seem to have been equipped for emergencies with bandages...”¹¹ These bandages were made of plant products and woven materials such as wool, cotton and flax.¹²

Not every wound treatment was as simple as wrapping it with a bandage. Often wounds required treatment from field doctors, known as *medici*, who cared for sick and wounded soldiers, “in well-designed and carefully built hospitals which provided insulation, quietness, and reduced likelihood of infection.”¹³ During the latter part of the Empire, around the time of Emperor Trajan (c. AD 53–117), field hospitals – *valetudinaria* – were constructed to accommodate approximately 200 men.¹⁴ The type of injury dictated a *medici's* course of action. Fractures were set with splints and any laceration was treated and covered with, “a variety of salves diluted in wine and made from a combination of salts (copper acetate, copper oxide, lead oxide), vinegar, nuts, flowers, grease, and fragrance (myrrh or frankincense – both bactericidal as well as fragrant).”¹⁵ With the number of deaths that Rome suffered from being almost constantly at war, the Romans could not

afford to lose many men to wounds and injuries. For this reason, when a man was found fit to fight again, he was sent back to the legions as soon as possible.

Once soldiers have been discharged for medical reasons, it is not usual to grant reinstatement on the grounds that they have recovered good health, since soldiers are not lightly discharged and only after doctors have declared that they have contracted an infirmity and this has been rigorously investigated by a suitable judge.¹⁶

With the cost of wars already extravagant, finding ways to reduce costs in training and equipping the legions was a priority. The more veterans who survived and the fewer new recruits the army had to train provided one method of cost reduction; now less money was spent on training and could be spent elsewhere.

As a medical practitioner, Galen himself used materials such as nut-juice and honey as well to make his remedies.¹⁷ Prior to his work as the personal doctor of Emperor Marcus Aurelius (AD 121 – 180), Galen polished and fine-tuned his practices as the head doctor of the gladiators in Pergamum.¹⁸ It was here that he practiced new treatments, such as the one for wounded tendons, and he altered techniques of previous doctors for such wounds:¹⁹

Earlier in his career, Galen had completed his studies and had been appointed physician to the gladiators in his hometown of Pergamum, now in modern Turkey. This afforded him excellent opportunities to observe a variety of anatomical conditions, wounds and other injuries of all kinds, and to record his findings.²⁰

Galen’s time working with the gladiators provided him with medical knowledge that continued to be used by his colleagues for centuries. Galen was the first to understand that optimal healing conditions included keeping the wound moist: “in his view keeping the wound moist was of great importance. He soaked linen cloths in wine and placed the folds on the wounds, covering the cloth in soft sponges which he moistened day and night.”²¹ The combination of moisture and acidity depleted the growing conditions of bacteria enough to interrupt any growth.

Just as soldiers lost in battle were not easily replaced, *lanistas* (trainers of gladiators) and *editores* (sponsors of gladiator games) could not afford to lose gladiators in the arena. “When a gladiator died or became disabled for a long time, the *editor* had to pay much more than the cost of his participation in a combat.”²² For this reason, any injured gladiator was given the best medical treatment possible. It is possibly for this reason that Galen developed certain medical philosophies, such as his “Therapeutic Method.”

So, taking as a starting-point, something agreed by all, this will be the business of the therapeutic model: to bring about health in bodies that are diseased; that is, to restore the natural activities of the parts wherever they happen to be impaired.²³

The ideas and philosophies developed by Galen reshaped how the Romans tended to their wounded. However, this is not to say before Galen soldiers did not address their wounds at all, though therapeutic treatment of wounds may not have been as prevalent prior to Galen. Commanders such as Julius Caesar (100 BC – 44 BC), saw the value in wound treatment. Not losing men in battle meant that he could focus his time elsewhere and not on dwindling manpower or having constantly to recruit and train new men; they could focus on conquering the world:

Under stress of this emergency Caesar had, by soliciting private individuals with touching appeals, amassed a certain amount of corn in his garrisons, and this he was using sparingly. Meanwhile every day he went round the field-works in person, and doubled the number of cohorts on guard duty in view of the large numbers of the enemy. Labienus gave orders that his wounded, who were very numerous, should have their wounds dressed and then be carried in carts to Hadrumetum.²⁴

When compared to modern medical technology, the medical remedies and treatments used by Galen and Caesar seem archaic at best. The use of plants and nature-made materials to aid the healing process evokes exotic images of medicine men and primitive understandings of medicine. There is, however, empirical evidence supporting the techniques and materials used by the Romans for medical treatment. Many of the products had naturally occurring bactericidal properties – the ability to stop bacterial growth.²⁵ These types of treatments are known today as topical antiseptics. When dealing with infections such as *C. perfringens*, which causes inadequate blood supply to infected areas, these types of antiseptics are highly effective as they are applied directly to the site of infection and have little distance to travel before encountering the pathogen.²⁶

Vinegar, known scientifically as acetic acid, has cleansing properties that make it a suitable antiseptic. Commonly used in “wound bed preparation,” the application of vinegar aids in the elimination of dead tissue and bacteria living in the wound:

Wound bed preparation refers to the clearance of necrotic and/or sloughy materials from the bed of the wound to produce granulation tissue. In the case of infected or necrotic tissue, the wound must be prepared either by using surgical debridement or by a progressive local treatment that eliminates dead tissue.²⁷

When applied to open wounds, the acetic acid enters the bloodstream and lowers the pH in the infected area, ultimately producing an acidic environment around the injection/infected area.²⁸ As

environments change and become more acidic, the bacteria growing in these areas react negatively; their growth rate decreases as an environment continues to become more acidic.²⁹ A similar effect happens when wine is used as an antiseptic agent. Wine creates a more acidic environment for the bacteria to live in, killing more bacteria as the environment continues to increase in acidity .

Olive oil was also used in treatment of lesions; it was applied to bandages and wrapped around wounds, keeping the environment moist. Like the mechanism of vinegar and wine, olive oil effects the environment as well, however, it targets the pathogen’s internal environment instead of the surrounding. The essential oils of olive oil are believed to increase the permeability of bacterial membranes.³⁰ This increased permeability results in the leakage of fluid from the bacterium; which can lead to lysis – breakdown and destruction of the cell if not stopped. The essential oils also inhibit microbial respiration, the process by which individual cells breathe; a vital process for cell growth. Although *C. perfringens* is an anaerobic bacterium, it too carries out respiration, using instead sulfur, nitrogen or carbon compounds, instead of oxygen, to breathe.³¹

Olive oil use, specifically extra virgin olive oil, produces an anti-inflammatory effect, “due to the inhibition of the cyclooxygenase enzyme release which is involved in prostaglandins synthesis.”³² Both cyclooxygenases and prostaglandins — active fat compounds — are important pro-inflammatory mediators. When a pathogen enters the body, in this case *C. perfringens*, an immune response is triggered. On the surface of these pathogens are receptors known as PAMPs – pathogen-associated molecular patterns. These patterns are recognized by receptors on the surfaces of immune cells known as PRRs – pattern recognition receptors. The binding of these two receptors can set off responses ranging from phagocytosis - a process by which specific cells destroy and eat invading cells - to an inflammatory response.³³

Another key response is the formation of cyclooxygenase 2 (COX2) - an enzyme formed in the body. Induced by PRR activation in different immune cells, COX2 is vital for converting a fatty acid, known as arachidonic acid, into prostaglandins.³⁴ Inflammation seems to be the ideal response to an infection such as *C. perfringens*; immune cells are alerted to the infected area and make their way over to fight off any antigens and pathogens. However the inflammatory response, is a catch-22. If done properly, the infection is fought off and the body will return to its normal state. However, as with any complex process, there is always the possibility that something could go wrong.

Resolution of this acute inflammatory response includes the clearance of invading pathogens, dead cells, and damaged tissue; the activation of the systemic acute phase response and additional physiological responses, including the initiation of wound healing; and the induction of adaptive immune responses. However, if the infection or tissue damage is not resolved, it can lead to a chronic inflammatory state that can cause more local tissue damage and potentially have systemic consequences for the affected individual.³⁵

This is the major problem when dealing with an infection such as *C. perfringens*. Due to its rapid reproduction rate, this bacterium is growing at a much more rapid rate than the body can handle. When the inflammatory response occurs, there is no way for the body's immune system to catch up to the growth rate of *C. perfringens*. This induces chronic inflammation immediately, which is one of the reasons increased swelling and pain are the first signs of a *C. perfringens* infection.

Olive oil disrupts the inflammation process. While PAMPs and PRRs still connect with each other, indicating an antigen has entered the body, olive oil acts to stop PRRs from inducing the synthesis of cyclooxygenase. This ultimately prohibits arachidonic acid from converting into prostaglandins and therefore stopping an inflammatory response. By disrupting this process, olive oil, and its essential oils, act as efficient anti-inflammatory agents.

Another anti-inflammatory agent the Romans used was honey. First used by the Egyptians around 1400 BC, honey has been used for centuries in medical practices.³⁶

Honey has been used for its healing properties for centuries and has been used to dress wounds with promising results. Honey dressings increase healing, minimize debridement, prompt successful graft, remove dry crust, prevent dry scab formation on burns, cleanse wounds, ease separation of sloughs, deodorize wounds, cause soothing of wounds, and minimize scar formation.³⁷

Numerous studies have analyzed the antimicrobial and anti-inflammatory effects of the use of honey to treat wounds. When honey is applied to a wound, research has found that this stimulates the release of cytokines – small proteins important in cell signaling – which aid in regulating the intensity and duration of an immune response, depending on which cytokine was released.³⁸ This response is highly regulated as excessive cytokines can cause an amplified inflammation response and characteristics similar to septic shock.³⁹ Honey is also full of endotoxins - toxins found on the walls of cells that releases when the cell disintegrates. These endotoxins activate macrophages - specific immune cells that perform phagocytosis - in order to produce pro-inflammatory cytokines.⁴⁰ Interestingly, honey has also been found to have anti-inflammatory properties. The exact mechanism for this property is unknown, however it is believed that similar to olive oil, honey inhibits prostaglandin synthesis.⁴¹

Researchers have found several mechanisms of actions used during the healing process by honey.⁴² It is remarkable that honey has two pathways that counteract each other; anti-inflammatory and pro-inflammatory. It is believed that the situation with which the honey is being used determines which of those two pathways it uses – if levels of inflammatory mediator are high or low.⁴³ For an infection such as *C. perfringens*, both pathways could be utilized. When honey is applied at the beginning of the infection, it could recognize that there are too many inflammatory mediators, causing the swelling and pain, which would cause the honey to act as an anti-inflammatory mediator. However, if the honey were applied later there may be fewer inflammatory

mediators in use, allowing the honey to produce more of a pro-inflammatory response. By having both pro- and anti-inflammatory properties, honey increases its medicinal uses making it a highly effective antiseptic.

The Roman legions comprised one of the most powerful and well-trained armies in the ancient world. They were a model of discipline and, for the most part, respected their commanders. Constantly being at war created serious problems for the soldiers. . The Roman army lost many men due to death on the battlefield, and some from their injuries after. It was too costly and time consuming to lose so many men; having to take the time to find new recruits, and then having to train them took away from the veterans’ continued training. To take care of the men, soldiers were equipped with bandages and field hospitals were set up to care for the more critically injured.⁴⁴

There is much to learn from how the Romans took care of their wounded. The ultimate goal was to get soldiers healthy enough to get them back on the battlefield.⁴⁵ There was no complex, cure-all solution that was passed around to heal the men. Everyday products that were abundant in the Roman Empire were the key. While they may not have understood the exact science as to why these products worked, the Romans knew that they did help and could make people better and heal their wounds. Simplicity was the solution.

From the modern perspective we think of the world of Galen as superstitious and simple-minded. However, he and others alike wanted to heal people with remedies that worked:

For all of Galen’s many faces...we should not forget that he regarded himself primarily as an *iatros*, a healer of patients and a restorer and preserver of health. Indeed, the principal job (*ergon*) or aim (*skopos*) of the medical art, he repeatedly says, is the treatment of disease and preservation of health; and it is his primary responsibility as a doctor to carry out that job in an indefinite number of particular cases.⁴⁶

There is more than one reason why the Roman army was the most powerful army in the ancient world. Discipline and rigorous training formed it into an unmatched killing machine. Wound care that used natural products to help the soldiers regain their health and strength was a powerful contribution that aided the success of the army for centuries. At first glance, the actions of the Roman army and doctors seem exotic and unscientific. Covering wounds with wine, olive oil, vinegar and honey could be construed as having come from the imagination of a child. How can covering wounds with food products and beverages have any sort of medicinal properties? Yet, when one analyzes the modern scientific literature cited, we find that there was legitimacy to the remedies and techniques used to treat the wounds of Roman soldiers.

Although wound treatment was known before him, Galen set a precedent for medical procedures that, at the time, were considered superior and extremely advanced. For centuries many of his findings and practices were used throughout the ancient world until the advancement of science further developed his techniques and theories.⁴⁷ It is clear that the natural remedies applied

by Galen are not able to combat every disease and infection; however, there are many microbes they can defeat. Rome's army was able to take simple, everyday products such as wine, honey, vinegar and olive oil and use them to great advantage in their conquests, for both sustenance and wound treatment. The use of such simple products of nature maintained a military at which the modern world still marvels.

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