

# In Flanders Fields

## The Great War, Antoine Depage, and the Resurgence of Débridement

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### Objective

The care of traumatic wounds has evolved over hundreds of years, largely as a result of armed conflicts. The lessons learned during World War I in the treatment of extensive soft-tissue injuries proved invaluable in reducing infection and preventing loss of limb and life. Foremost among these was the use of débridement. This report reviews the development of débridement as standard treatment of war wounds and highlights the surgeon largely responsible for its resurgence during one of this century's saddest chapters.

### Summary Background Data

Before World War I, the care of wounds consisted of minimal exploration and liberal use of then-new antiseptics. For limited injuries, this approach appeared adequate. World War I saw the introduction of devastating weapons that produced injuries that caused extensive devitalization of tissue. Standard treatment of these patients proved woefully inadequate to prevent life-threatening infections.

### Methods

This is a historical review of the conditions that occurred during World War I that prompted a change in wound management. One of those responsible for this change was the Belgian surgeon Antoine Depage. His life and contributions to the care of war wounds are profiled. Depage reintroduced the discarded French practice of wound incision and exploration (débridement) and combined it with excision of devitalized tissue.

### Results

Through the use of débridement, excision, and delayed wound closure based on bacteriologic survey, Depage was able to reduce the incidence of infectious complications of soft-tissue injuries, particularly those involving fractures.

### Conclusions

Through his experiences in the Great War, Antoine Depage was able to formulate a treatment plan for wounds of war. All such injuries were assumed to be contaminated and, as such, they required early and careful débridement. Depage thought that wound closure should often be delayed and based his decision to close on the bacteriologic status of the wound. To him, we owe our current management of traumatic wounds.

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In Flanders fields the poppies blow  
Between the crosses, row on row,  
That mark our place; and in the sky  
The larks, still bravely singing, fly  
Scarce heard amid the guns below . . .  
John McCrae *In Flanders Fields* 1915

On August 4, 1914, German cavalry crossed the border into neutral Belgium to begin their invasion of France. Although Belgium fell quickly, Germany's

strategy for conquering France was thwarted at the Marne River. Further maneuvers by either side were unsuccessful, and the armies settled into trench warfare, which extended from the North Sea in Flanders to the Swiss border. For the next 4 years, gains or losses would be measured in terms of yards and lives lost, becoming a war of attrition. Paul Fussell commented<sup>1</sup>:

One did not have to be a lunatic or . . . particularly despondent to conceive quite seriously that the war would literally never end and would become the permanent condition of mankind.

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**Figure 1.** Antoine Depage (1862–1925) during his days as a colonel in the Belgian army. Despite personal tragedy from the Great War, he managed to develop clinical and research facilities that allowed assessment of results and modifications in treatment of war wounds. His approach to the terrible soft-tissue injuries of the war no doubt saved countless lives and limbs. (Courtesy College of Physicians, Philadelphia, PA).

The tiny Belgian army that had defended its homeland so valiantly came to occupy the most northern sector of the Allied trenches, north of Ypres, in the mud and rain of Flanders fields.

Antoine Depage (Fig. 1) was born on Nov. 28, 1862, the seventh of nine children, to Fredric and Elisabeth Depage in the village of Boitsfort, near Brussels. Depage began his study of medicine under the tutelage of Professor Paul Heger at the University of Brussels. He received his doctor of medicine degree in 1887 and trained for the next 3 years in physiology and biochemistry in Prague. During this time, he visited the surgical clinics of Thierch and Gusenbauer and the famous clinic of Professor Billroth in Vienna. Depage returned to Brussels in 1890 and joined the faculty of medicine at the university. Three years later, after a long courtship, he married Marie Picard, the niece of his mentor, Professor Heger. In a biography of his father,<sup>2</sup> Henri Depage wrote that Marie balanced the scientist-husband by exposing him to art, music, and painting. In return, Antoine encouraged his wife to learn anatomy so she could take

more accurate notes of his lectures. Once this was accomplished, Marie used her knowledge of anatomy and her skill as an artist to draw colored plates for her husband's students, thus complementing their lessons.

Antoine Depage's career advanced rapidly. In 1892, he participated in the establishment of the Société Belge de Chirurgie. In 1901, he was appointed chief of service at the Hôpital Saint-Jean and in 1904 chief of surgical services at the Hôpital Saint-Pierre. This led to his election to the Académie de Médecine in 1907. In November 1912, Depage left for the Balkans to organize Belgian hospitals for the hostilities among the Balkan states that had begun the previous month. He and his wife established the first of three Belgian hospitals at Constantinople, which began almost immediately to receive casualties of war. It is here that Depage made observations on the care of the wounded that would strongly influence his management of casualties 2 years later on the Western front.<sup>3</sup>

. . . there is a tendency for suppuration, especially when careless and hurried interventions are carried out on the field. Poorly equipped, moving daily (even by the hour), surgeons who are called to intervene on the battlefield must repress the desire to operate, and often only bandage wounds temporarily . . . Preventing the immediate or delayed infection of wounds as much as possible must be one of the main priorities of surgeons . . .

Based on his experience in the Balkans, Depage, as president of the Société Internationale de Chirurgie in 1914, delivered his presidential address on *Les enseignements de la chirurgie de guerre* ("Instructions in the surgery of war") at the annual meeting in New York in April. Caught in Belgium at the outbreak of the war, he remained until October and then escaped to Calais through Holland, where he was joined by his wife.

In November 1914, after his arrival at Calais, at the request of the Belgian Queen Elisabeth, a military hospital, or *ambulance*, was developed under the direction of Depage at La Panne, a coastal town located 10 km southeast of Nieuport and 12 km behind the trenches, to care for the wounded in the Belgian sector. As was the case with many *ambulances* during the war, the hospital was placed in a hotel, in this case a former seaside resort, the Hotel de l'Océan. Although initially built to accommodate 200 beds, by 1916 it had expanded to 900. Depage organized his *ambulance* into wings, or *pavillons*, where the casualties were segregated according to types of wounds (Fig. 2). Adjacent to his ambulance, Depage constructed research facilities to enhance the care of the wounded. The research institute examined the systemic reaction to wounding, host defenses in infection, repair of injured tissue, and various antibacterial agents.

To supplement the *ambulance*, Depage also organized mobile surgical units (Fig. 3) called *postes avances des hopitaux du front* (advance posts of the front hospitals), located only 3 to 4 km from the trenches. These units were

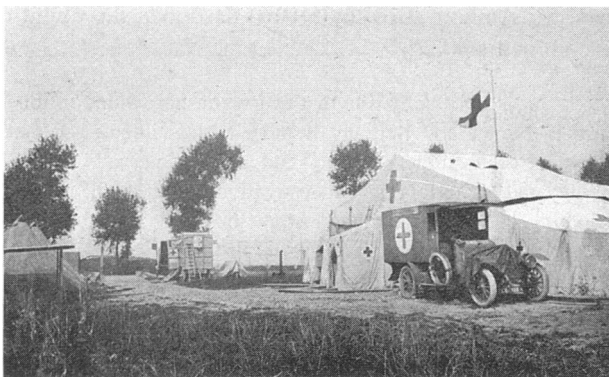


**Figure 2.** Depage's Ambulance de l'Océan, or military hospital, at La Panne on the North Sea, 10 km southeast of Nieupoort and 12 km behind the trenches. The view is looking out to sea. In the foreground, the quadrangular buildings are the research facilities, renamed the Institut Marie Depage after his wife's death aboard the *Lusitania*. (Depage, *A Ambulance de l'Océan a La Panne*).

designed to treat urgent wounds, particularly those to the abdomen and chest and those producing profound hemorrhage. The entire ensemble consisted of four automobiles and one trailer outfitted as an operating room. The wounded were kept in adjacent tents for 4 or 5 days and transported to the rear.

In the midst of his efforts to improve the plight of the war's casualties, Depage himself fell victim to its senseless tragedies. His wife, firmly committed to complementing her husband's work and to serving the Belgian cause, toured the United States to disseminate information on the plight of occupied Belgium. After a long visit, she boarded the *Lusitania* in New York to return to Liverpool. On May 7, 1915, off the Irish coast, the *Lusitania* was sunk by a single torpedo from a German submarine. Marie Depage was not among the 663 survivors. In his grief, and as a tribute to her, Antoine Depage named his research institute at La Panne the Institut Marie Depage. He never remarried.

From the dawn of the Renaissance, the care of war



**Figure 3.** One of the Belgian mobile surgical hospitals, called *postes avances des hopitaux du front*. These units were composed of several vehicles, a trailer to serve as operating room, and tents for recovery of patients. They were used to treat urgent surgical problems such as patients in shock and chest or abdominal injuries. (Depage, *A Ambulance de l'Océan a La Panne*).

wounds involved some type of mechanical or chemical cleansing in the belief that gunshot wounds were poisoned by gunpowder.<sup>4,5</sup> French surgeons of the 18th and early 19th centuries believed that inflammation or injury could, on occasion, produce constriction of soft tissues confined by fascia, tendons, or aponeuroses by *augmentation de volume*, or a rise in pressure. Such constriction, termed *étranglement*, might result in gangrene if left unattended. For this reason, *débridement* (Fr. *debrider*, to unbridle) was used: an incision was made through investing fascia to unbridle, or release, the underlying expanding tissue. Bleeding reflected viable tissue and was considered a favorable sign. Less encouraging was the release of putrid or watery fluid, indicating gangrene. Often, such *débridement* would drain pus from deep muscle abscesses, particularly in wounded areas.

Although some based the practice of *débridement* on the teachings of the French surgeon Pierre Joseph Desault (1744–1795),<sup>6</sup> it apparently began before his time. Henri François LeDran (1685–1770), believed, like many of his contemporaries, that incising into muscle compartments was essential to release pressure from bleeding, injury, or inflammation.<sup>7</sup> This practice was much like the present-day fasciotomy for compartment syndromes—which, as we now know, can cause ischemic damage or frank gangrene if not treated by incising fascia. However, *débridement* was not consistently practiced. It was thought that the inflammation that produced the *étranglement*, or constriction, more often ended in suppuration and not gangrene, so that any operative intervention might only aggravate the situation.

In fact, a contemporary of Desault's, Pierre-François Percy (1754–1824), expressed caution about the practice but also provided indications for *débridement*,<sup>8</sup> including “wounds which involve tendons, aponeuroses, . . . foreign bodies, . . . fractures, fragments, or hemorrhage, or those with a long or tortuous trajectory.” Similarly, disciples of the master surgeon Baron Guillaume Dupuytren (1777–1835) found *débridement* to be the most efficacious way to stop the *étranglement*, but argued that it should be done only under certain circumstances,<sup>9</sup> particularly in wounds with narrow openings and with long tracts, and in wounds caused by gunshot or cannon. The renowned military surgeon Dominique Jean Larrey (1766–1842) used *débridement* to release ecchymotic wounds, to remove foreign bodies, and to uncover and ligate arteries if the wounds were hemorrhagic.<sup>10</sup> So focused on the liberating effect of *débridement* was Larrey that he discouraged the use of the technique in areas without muscle or fascia except, perhaps, to look for a bleeding artery to ligate. He alluded to the actual excision of contused skin edges on only one occasion, a technique he referred to as *refraicher*, “to freshen up,” before primary closure.<sup>11</sup>

The famous English surgeon John Hunter (1728–1793), despite recommendations to expose the orifice of all gunshot wounds, believed that these injuries should be opened only in cases in which the wound was slight, an artery was injured, bones were fractured, or foreign bodies were

present.<sup>12</sup> Hunter knew that dead tissue impeded healing,<sup>13</sup> but he was more inclined to rely on suppuration to effect healing, arguing that débridement only augmented inflammation. Other English surgeons thought similarly.<sup>14,15</sup>

After the collapse of the Napoleonic empire, the practice of débridement was largely forgotten. Surgeons were hesitant to invade deep into tissue lest they damage vessels or nerves or encounter uncontrollable bleeding. Minimalism was the rule. The American Civil War gives us a good insight into the state of wound care at this time<sup>16</sup>:

. . . balls and foreign bodies were extracted, bleeding vessels secured, and splinters of bone removed . . . In determining the extent of injury it was not unusual to enlarge the wound caused by the missile, especially in cases where . . . swelling caused difficulty or uncertainty of touch, or where . . . necessary to remove splinters or foreign bodies.

Most wounds were not explored. Only 3% of “shot” wounds to the extremities were followed by excision, as recorded in *The Medical and Surgical History of the War of the Rebellion*. Overall, 17,421 patients (12%) died of their wounds.<sup>18</sup> Minimal care sufficed in the vast majority of casualties.<sup>18</sup> Projectiles were of low velocity, largely inaccurate beyond a few dozen meters, and produced little devitalization outside the immediate missile tract. In fact, more aggressive wound management, such as débridement, would probably have resulted in more complications. Only compound (open) fractures were addressed radically, and these were almost always treated by amputation.

In 1867, Joseph Lister revolutionized the care of open fractures with the use of carbolic acid to sterilize the wound.<sup>19</sup> Although he realized the noxious qualities of “decomposing animal matter” on wound healing, Lister still favored his antiseptics over removing devitalized tissue. He believed that incising the wound for adequate drainage of “foul discharges” violated Hunterian practices and rendered suppuration certain. Instead, the antiseptic solution was believed sufficient to deal with airborne microcontaminants.

As a result, the focus of wound care switched from surgical to medicinal. Pilcher (1883) wrote that for wounds of “considerable extent,” the skin should be cleaned thoroughly with soap and water, brush and razor, and “purified” with carbolic acid. The existing wound opening could be enlarged with a knife to allow removal of coagulum and foreign matter. He stressed irrigation with an antiseptic solution.<sup>20</sup> This approach seemed satisfactory for most civilian injuries and the occasional military wound of low velocity. During the Russo-Turkish war of 1877, Russian surgeon Carl Reyher (1846–1890) practiced a sort of wound excision he termed débridement, combining it with antiseptic use. His mortality rate, however, remained unconvincingly high (24% of 55 patients),<sup>21</sup> and his admonition to excise wounds went largely unheeded.

Thus, the advent of World War I found surgeons attempting to treat wounds as they had in the previous century. Débridement was a technique that belonged to antiquity—

too invasive and of doubtful benefit. Lister’s antiseptics was all the talk, and in a society preoccupied with modernism, little attention was given to the dusty teachings of long-dead surgeons.

Indeed, beneath a grand facade, modern technology was producing weapons that would propel humanity back to a savagery thought extinct in civilized nations. The Great War showcased far more formidable weapons than those of the *fin de siècle*. Rifle bullets were much more accurate and damaging. The machine gun became an extremely effective weapon against massed infantry, and above all, artillery achieved terrifying success with the use of both shrapnel and high-explosive charges. High-explosive shells, in particular, were feared because of the magnitude of the charge and the ability to inflict horrifying wounds by fragments of all sizes on a scale never before witnessed. Artillery ranged in size from the French 75-mm field gun to the enormous German trench mortars, which fired shells weighing more than 900 kg (nearly a ton). For the initial German assault on Verdun in February 1916, more than 1220 pieces of artillery were assembled for a front of barely 8 miles.

As a result, proportionately more wounds were caused by these artillery projectiles. From one *ambulance* in the French sector, in the valley of the Moselle, Chalié and Glenard<sup>22</sup> reported that 634 of 1500 casualties (42%) were the result of artillery projectiles and 46% the result of small arms. By contrast, only 8% to 14% of casualties were from artillery fire in the turn-of-the-century Russo-Japanese War. The preponderance of casualties who reached the hospitals alive had injuries to the extremities (Fig. 4), head and truncal wounds often being immediately fatal. Along the French lines, 41% of casualties had leg wounds and 34% upper extremity wounds, whereas 12% each had head and trunk injuries.<sup>23</sup>

The trenches of the Western front were dug into fertile farmlands of northern France and Belgium, land that had been cultivated and manured for centuries. Men lived and died in this soil, which was rich in pathogenic anaerobic organisms, spores of microbes that could remain viable for years. Sir Anthony Bowlby (1916) described the plight of the common soldier:<sup>24</sup>

. . . it is practically true that every gunshot wound of this war in France and Belgium is more or less infected at the moment of its infliction . . . mud and dirt pervade everything; and bacteriological investigations of the soil, of the clothing, and of the skin demonstrate the presence of the most dangerous pathogenic organisms in all three.

Indeed, Alexander Fleming, who did many of his bacteriologic studies in the research laboratories of Depage’s *ambulance* at La Panne, wrote that of 12 clothing samples taken from wounded soldiers, 10 contained *B. aerogenes capsulatus* (*C. perfringens*, *C. welchii*), 4 *B. tetani* (*C. tetani*), 5 streptococci, and 2 staphylococci.<sup>25</sup> That these bacteria had time to infect there is little doubt: on many occasions, the seriously wounded would lie in no man’s



**Figure 4.** Wounds of the Great War produced soft-tissue injuries never before encountered. Coupled with the contaminated soil on which the conflict was fought, it is no wonder that injuries such as these resulted in rampant infections and gangrene if not properly treated. (The Liberty Memorial Museum, reproduced with permission).

land for hours, if not days, until night fell or a mutual truce could be arranged to allow their safe evacuation to medical care. The dead were sometimes left indefinitely to rot before the trenches and often became part of the terrain as artillery pulverized them into the dirt and mud, adding to the microbial morass.

The combination of devastating wounds, contaminated soil, poor evacuation, and surgical minimalism produced an abundance of soft-tissue infections at the outset of the war. Some estimated that as many as 10% of casualties developed one form or another of gas gangrene, then called *gangrene gazeuse*. Almost half of those affected died. *Gangrene gazeuse* actually represented a host of soft-tissue infections. Chalier and Glenard<sup>22</sup> described four varieties: *phlegmons gazeux*, a more indolent infection that could present as a localized or diffuse process, one usually extruding a foul-smelling chocolate pus (probably what we would now recognize as some form of necrotizing fasciitis); *gangrenes humides* (moist gangrene), with or without gas, an infection developing in a crushed or devitalized extremity, causing massive necrosis, probably clostridial myonecrosis (Fig. 5); *manifestations cutanées des plaies infectées* (cutaneous manifestations of infected wounds), likely an



**Figure 5.** The feared *gangrene gazeuse*, or gas gangrene. Although *gangrene gazeuse* was a spectrum of soft-tissue infections, this patient probably suffered from clostridial myonecrosis, which carried a mortality rate in excess of 50%. Amputation was often the only alternative. (The Medical Department of the United States Army in the World War. Washington DC: Government Printing Office).

erysipeloid process akin to streptococcal cellulitis, which could occur independently or in association with other infections; and *emphysema mecanique* from wounds near the rectum or perineum (most likely Fournier's gangrene). These gas-forming infections were actually the result of a variety of organisms, including  $\beta$ -hemolytic streptococci, clostridial species, anaerobic streptococci, staphylococci, and other gram-negative bacteria. The pathogens produced what we now recognize as a spectrum of soft-tissue infections such as clostridial and nonclostridial necrotizing fasciitis, often containing a polymicrobial mixture of anaerobes and aerobes, and clostridial and nonclostridial (usually anaerobic streptococci combined with *Staphylococcus aureus*) myonecrosis.<sup>26</sup>

Even in the face of such rampant infections, surgeons were hesitant to forego their reliance on accepted practices. Some, such as the British surgeon Sir W. Watson Cheyne, were reluctant to relinquish their faith in antisepsis as "a less brutal and more gentlemanly plan."<sup>27</sup> Cheyne advocated wide exposure of the depths of the wound, but only for introducing antiseptics. There was no mention of removing devitalized tissue. Sadly, Lister's procedure for disinfecting wounds with the use of carbolic acid, although it produced amazing results with compound fractures, would not be enough to deal with the mayhem caused by this war. Despite a brief report by the British surgeon E.T.C. Milligan<sup>28</sup> on the value of separating dead from viable tissue rather than using antiseptics, the importance of thorough exploration and excision was not yet appreciated.

In the French sectors, surgical practices were no different. René Lemaitre recounted his experience from the early days of the war:<sup>29</sup>

We would satisfy ourselves with disinfecting the start of the trajectory of the missile and the surrounding skin with tincture of iodine, removing surfacing foreign bodies, and applying a sterile bandage. We would only operate on obvious vascular injuries, mangled extremities necessitating amputation, penetrating wounds to the cranium or abdomen, and the two to three day old wounded whom we received with a raging infection. All the other cases were placed in observation after bandaging.

However, gas gangrene, secondary hemorrhages, and, at best, suppuration flourished. Casualties mounted, infections raged, and hospitals were inundated with lingering cases of decaying bodies. In the early days of the war on the Western front, it became painfully obvious that wound care must change to accommodate the numbers of victims from the trenches. Minimal exploration, reliance on antisepsis, and primary closure had proved ineffective in combating life- and limb-threatening infections.

Antoine Depage was keenly aware of the unique challenges faced by surgeons in wartime. Mass casualties and extreme injuries required an efficient and organized evacuation system. In this regard, his experiences in the Balkan wars of 1912 served him well. On his arrival at La Panne, he began to piece together a strategy for the care of the injured

soldier beginning at the front.<sup>30</sup> His goal was to treat "mortal" complications first and to cover other wounds from further contamination until the casualties could be transported to the front-line ambulances for definitive care.

Depage's underlying principle in treating war wounds was that all wounds of war must be considered contaminated or infected. In close collaboration with the bacteriologists, he developed an approach to the treatment of these mutilating injuries. He published his method in 1917 as part of his reports from his ambulance at La Panne,<sup>31</sup> titled *Le débridement des plaies de guerre*. Central to his treatment, Depage resurrected the practice of débridement, or incisional wound exploration, the much-maligned technique of Napoleonic surgeons to deal with deep gunshot injuries. In fact, he considered it prudent to explore most wounds, even seemingly trivial ones, because he believed:

. . . the bullet almost always causes the tissue to burst, and has a true shredding effect, with an attrition zone more or less deep, exposed to mortification. It would be less than prudent to withhold operation.

For shrapnel and fragment wounds, it was even more important to explore extensively to remove all but the smallest missiles, because there was no doubt they were infected. He explained the reason for his débridement:

The débridement, by opening widely the confused center, decompresses the tissues strangulated by the constrictions of aponeuroses. The surgeon tries to prevent septic and serious complications and to place the wound in the most favorable conditions for healing and suturing.

But for Depage, simple débridement, or wound exploration, was not enough. In the course of débridement, it was important not only to eliminate foreign bodies harboring microorganisms but also to remove contaminated tissue and contused, necrotic flesh. He feared this environment was fertile ground for the growth of pathogens, particularly the spore-forming anaerobes responsible for many cases of *gangrene gazeuse*.

He described in great detail how this was to be accomplished. There were two phases to his technique: exploration and excision. The incisions for wound exploration, his débridement, should be planned according to the trajectory of the missile, the location of the entrance and exit sites, and any pertinent radiographic findings. He was careful to mention that incisions on the extremities generally should be parallel with the extremity and not transverse to avoid injuring nerves, vessels, and tendons. Each incision was to be carried through the subcutaneous tissue into the muscle fascia as widely as the skin incision for proper inspection of the muscle compartments. The process of excision then began. All mangled tissue that lined the wound was removed. Muscle was particularly likely to suffer from the shearing effect of jagged missiles and must be excised:

Damaged muscle must be resected all along the wound, until healthy tissue is encountered. Healthy tissue is recog-

**Table 1. METHOD OF WOUND CLOSURE AMBULANCE DE L'OCEAN MAY 1916 TO NOVEMBER 1917\***

Method	Total	Complete Success (%)	Partial Success (%)	Unsuccessful (%)
Immediate suture				
Head, face, hands, feet	491	415 (96.5)	8 (1.6)	10 (2.1)
Major joints				
With bony lesions	66	62 (95.9)		4 (4.1)
Without bony lesions	79	71 (89.9)	1 (1.2)	7 (9.0)
Soft tissue	380	310 (83.9)	24 (6.5)	30 (9.8)
Fractures				
Femur	4	4 (100)		
Other bones	26	20 (76.9)	3 (11.5)	3 (11.5)
Delayed primary suture				
Head, face, hands, feet	18	18 (100)		
Soft tissue	222	207 (93.2)	8 (3.6)	7 (3.2)
Fractures				
Femur				
Other bones	20	16 (80)	4 (20)	
Secondary suture				
Head, face, hands, feet	64	58 (90.6)	4 (6.2)	2 (3.3)
Soft tissue	845	724 (85.6)	70 (8.0)	51 (6.4)
Fractures				
Femur	39	30 (76.9)	7 (17.0)	2 (5.2)
Other bones	103	92 (90)	3 (3.0)	7 (7.0)

\* Depage, *A le débridement des plaies de guerre*.<sup>35</sup>

nized by its contractility, and by its red tint, which stands out against darker, damaged muscle.

Of course, during the procedure, foreign bodies and pieces of clothing, as well as loose bone fragments, were also removed.

Despite the temptation to close the wound primarily (*suture immédiate*), Depage recognized that many were still likely to be contaminated, and immediate closure would invite suppuration or gangrene. For these, he introduced the concept of delayed primary closure, which he termed *suture primitive retardée*. He also mentioned that some wounds should not be closed for several days or even left to heal entirely by granulation (*suture secondaire*). *Suture immédiate* was reserved for wounds involving joints, those of the scalp, face, feet, and hands, open fractures, and the occasional clean soft-tissue wound. Delayed primary closure required close cooperation with the bacteriologist and was performed only after microbial control:

During the first dressing (12 to 24 hours after the débridement), we take a brushing for direct examination, and submit it for culture. During the second dressing (36 to 48 hours after débridement), we take a new brushing. If the first culture does not reveal streptococcus, and if there are no more than two microbes per field, we suture the wound.

He cautioned against closing the wound if any bacteria were present. *Suture secondaire* was used for those that could not be sterilized. His results in treating 2363 wounds from May 1916 to November 1917 are presented in Table 1. Indeed, most face wounds were successfully closed primar-

ily, with only a 2.1% failure rate. In contrast, almost 10% of soft-tissue wounds and 11.5% of open fractures failed with *suture immédiate*. With delayed primary closure, the failure rate dropped to 3.2% for soft-tissue injuries and to zero for open fractures.

Depage argued that antiseptics were strictly an adjunct to wound care and could not supplant wound débridement and excision. He worked with Alexis Carrel, who had been investigating the sterilization of wounds since 1914 in his clinic at Compiègne. Carrel and the English chemist Henry Dakin developed a solution consisting of hypochlorite of soda. This was introduced through tubes placed in the wound for continuous irrigation. Although Carrel thought his solution was instrumental in reducing infections, he was quick to acknowledge the vital role of surgical excision:<sup>32</sup>

The bruised portions of the [wound] tract are carefully excised. To Depage and the surgeons of his school is due the merit of having shown how useful it is to resect almost the whole of the area of the wound . . . No amount of mopping or scrubbing is capable of getting rid of them [debris]. They can only be removed by removing the tissues themselves.

Depage favored the solution of Carrel and Dakin because it dissolved secretions, facilitating their elimination from tissue, and because it was minimally caustic and thus did not slow healing.<sup>33</sup>

Based on his work at the Ambulance de l'Océan at La Panne, Depage greatly influenced the proceedings of the Interallied Surgical Conference held in March 1917 to dis-

cuss wounds of war. The meeting was attended by representatives from Belgium, France, Italy, Japan, Portugal, and Serbia. In large part because of his results, the conference reached a consensus on a number of issues regarding the wounded, including continuity of surgical care, rendering minimal treatment at the front, rapid transport of casualties to surgical hospitals for definitive care, and the use of débridement and excision.<sup>34</sup>

The wide débridement of the wound, with resection of contused tissue and removal of particles of clothing and other foreign bodies, must be considered a strict rule . . .

Moreover, Depage argued that primary closure should be withheld except in the most favorable situations or with articular injuries. Eventual closure (either delayed primary or secondary closure) should be closely linked to bacteriologic assessment of the wound. By these methods, the incidence of *gangrene gazeuse* seen so often at the beginning of the war could be drastically reduced.

The war that seemed endless did, in fact, have an end. Fresh American troops bolstered the sagging morale and mounting attrition of the French armies, and, in one final fall offensive, the Allies managed to push the depleted and similarly haggard German forces to an armistice agreement on Nov. 11, 1918. Four years of pointless trench warfare had cost the French 3 million casualties, the English more than 2 million, and the Germans almost 5 million.

For Depage, the war's end brought fresh opportunities to share his experiences about the care of the wounded. He visited the United States in 1919 and spoke before the American Surgical Association on June 16. He reviewed his work at La Panne and emphasized the importance of débridement:<sup>35</sup>

In general, all wounds inflicted by war fragments or from grenades, as well as the wounds by shrapnel or of bullets . . . were freely opened up immediately upon arrival of the wounded at a hospital organization sufficiently equipped. At the same time the contused and lacerated tissues which constituted a medium favorable for microbic growth were cut away with the greatest care so that there was effected veritable "epluchage" of the wound . . .

Depage spoke of *epluchage*, a combing or peeling of the wound to remove all traces of tissue damage, as an integral part of débridement. To others, débridement alone came to mean exploration and excision of nonviable tissue. Dr. Dean Lewis of Chicago summarized his feelings on wound débridement in a presentation to the American Medical Association in June 1919:<sup>36</sup>

Débridement, employed so extensively in war surgery, is a procedure which could be used to advantage more commonly and more extensively in the traumatic surgery of civil life.

Débridement had become etched in the medical vernacular. The resurgence of this controversial practice of 18th-

century French surgeons provided an indispensable element in the prevention of life- and limb-threatening infections after injury. To change the nature of a wound and effect a cure, one must indeed use débridement.

After the war, for his contributions and achievements, Antoine Depage received various accolades. He was awarded the highest civilian decoration in France, the Legion d'Honneur, and presided over the 29th French Surgical Congress, only the second non-French surgeon to do so. In 1923, Depage traveled to Morocco and contracted pneumonia. He immediately returned to Belgium. Several months passed before he was completely recovered. Barely up and about, he suffered thrombophlebitis, which kept him bedridden. In March 1925, the phlebitis had resolved, but he was diagnosed with an intestinal obstruction. He thought he had cancer. He was apparently so fearful that others would not tell him the truth that he underwent a celiotomy under local anesthesia, watching the surgeons with a mirror. The intestinal obstruction was not caused by cancer, rather by mesenteric venous thrombosis. He underwent two more operations for this condition but to no avail. He died after his third operation on June 10, 1925.

In Flanders fields, blending history and science, Antoine Depage discovered the solution to a medical enigma of the First World War. He forever adjusted the standards of wound care and added débridement to the armamentarium of trauma surgeons.

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