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TRAUMA CARE IN WAR AND PEACE: THE ARMY/AAST SYNERGISM: 1992 FITTS LECTURE

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WILLIAM T. FITTS, JR., MD, who is memorialized by this lecture, became a citizen soldier in 1942 when he was assigned to the newly organized 20th General Hospital. In preparation for field duty, Dr. Fitts trained with other hospital personnel at Fort Polk, Louisiana, before moving to the China-Burma-India Theater (Fig. 1). The hospital, affiliated with the University of Pennsylvania and commanded by Dr. Isidore Ravdin, was established at Margherita near Lido close to the Burmese border in northeast India. The hospital first received patients on April 27, 1943 and expanded progressively until, by June 1944, it operated 2000 beds to accommodate the American and Chinese casualties from the second Burma campaign.¹ The experience that Dr. Fitts gained while on active duty provided him an expertise in fracture management which he maintained when he returned to the Department of Surgery at the University of Pennsylvania, and formed the basis of his authorship of the fractures and dislocations chapters in *Surgery, Principles and Practice* by Harkins, Moyer, Rhoads, and Allen, a standard surgical text of the 1950s and early 1960s.² Dr. Fitts brought his understanding of wartime surgery and the surgical needs of the military services to his activities as President of this organization, Editor-in-Chief of the *Journal of Trauma*, and Chairman of the Department of Surgery at the University of Pennsylvania. In short, Dr. Fitts' career in and out of uniform exemplifies the synergism that has existed between the American Association for the Surgery of Trauma and the medical departments of our Armed Forces since the Association's first meeting.

President Kellogg Speed called the first Annual Meeting of the American Association for Traumatic Surgery to order at 9:30 Monday morning, May 8, 1939. "The Association immediately went into executive session. The Secretary then presented a short report of the Council. In this report the Council recommended to the Association the names of the following gentlemen for Hon-



Figure 1. In 1942 Lt. Bill Fitts visited his family's home in Jackson, Tennessee, on his way to join the staff of the 20th General Hospital in training at Fort Polk, Louisiana (Photo courtesy of C. Thomas Fitts, MD).

orary Fellowship: Drs. William J. Mayo, Rudolph Matas, J.M.T. Finney, Robert Carothers, Admiral Ross T. MacIntire (Surgeon General of the Navy), Major General C. R. Reynolds (Surgeon General of the Army), and Colonel James C. McGee, also of the U.S. Army. It was moved and seconded that this report be accepted and this motion was passed."³ The Association also adopted a logo in which the prominently displayed field piece gives recognition to the role that warfare has played in the advancement of trauma surgery. The close relationship between the military medical services and the AAST, established at the first Annual Meeting, has

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distribution is unlimited.

From the U.S. Army Institute of Surgical Research, Fort Sam Houston, Texas.

The opinions or assertions contained herein are the private views of the author and are not to be construed as official or as reflecting the views of the Department of the Army or the Department of Defense.

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persisted to this day. The U.S. Army/AAST synergism is symbolized by the gavel, mentioned by President Flint yesterday morning, which was made from a patient litter used in Vietnam and presented to the Association at the 50th Anniversary meeting (Fig. 2). The important interactions between the military medical services and the American Association for the Surgery of Trauma, evident in the military service of our members, the key roles that they have played in the clinical investigations carried out during three major conflicts, and in the annual programs of the Association, have significantly benefited the military services, the AAST, and, most importantly, trauma patients.

The members and officers of this Association have in a very real sense practiced what they preached and have served as military surgeons in all wars and conflicts since the AAST inaugural year of 1939. The results of a survey of Past Presidents of this Association indicate the magnitude of the direct involvement of our members in the military medical departments. Information from 25 of the 30 most recent Past Presidents documents that all have served in the Uniformed Services of the United States, Canada, or the United Kingdom or as consultants to the military. Twenty-two served in the Armed Forces either as physicians (18) or in some other branch when they were drafted before attending medical school (six). Two Presidents served first as nonphysicians and later as surgeons. Fifteen Past Presidents served on active duty as physicians during a period of conflict; six during World War II, five during the Korean conflict, four during Vietnam and two during Operation Desert Shield/Desert Storm. In that group, one was an infantryman in World War II and in the Korean conflict served as a surgeon, and was a model for "Hawkeye" in the novel *M*A*S*H*, and two served during both the Vietnam conflict and the recent Operation Desert Shield/Desert Storm (Table 1).

The importance of the members of the American As-

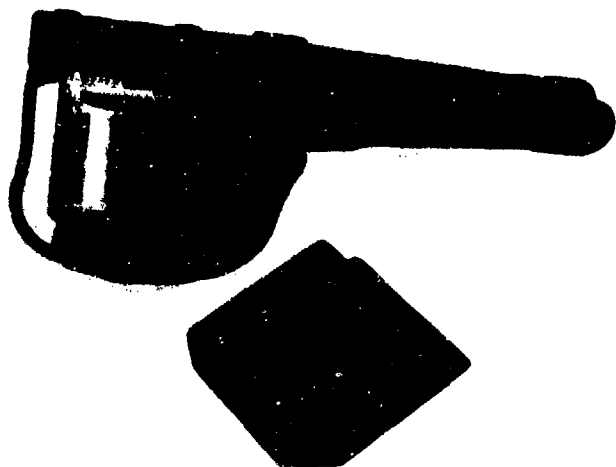


Figure 2. Gavel constructed from patient litter used in Vietnam, which was presented to the AAST at its 50th Anniversary Annual Meeting.

Table 1
Military service of recent AAST Presidents

Active duty or consultant status in a uniformed service	25
Active duty as physician	18
Active duty as physician during World War II	6
Active duty as physician during Korean Conflict	5
Active duty as physician during Vietnam war	4
Active duty as physician during Operation Desert Shield/Desert Storm	2*

* Both previously served in Vietnam.

Table 2
Physician Staffing, U.S. Army medical units, RVN

	Mid-1962-1966 (%)	Mid-1966-1972 (%)
Regular Army	62	32
Obligated volunteers	38	68

sociation for the Surgery of Trauma to the military medical services is obvious when one realizes that there are only 173 general surgeons on active duty in the U.S. Army. Twenty-one Army physicians complete general surgery residency each year and maintain a relatively constant Army population of general surgeons.⁴ The modest size of that surgical cadre explains the critical need for civilian augmentation of surgical capability during times of conflict. The number of civilian physicians drafted during World War II (as were Dr. Fitts and five other AAST Presidents) and during the Korean conflict (as were Dr. Davis and four other AAST Presidents) is well known to all.* The need to use civilian physicians for the rapid expansion of the Medical Corps in the major conflicts of this century was responsible for continuation of physician draft eligibility under the Berry Plan long after the draft had expired for everyone else. In Vietnam the reliance of the Army on civilian physicians was directly related to the intensity of the conflict and density of casualties. In the period 1962 to mid-1966, 62% of the physicians on active duty with the U.S. Army units in the Republic of Vietnam were Regular Army physicians and only 38% were obligated volunteer members of the reserve. In contrast, during the intense combat period of late 1966 through 1972, that ratio was reversed, so that only 32% of the doctors were Regular Army physicians and 68% were obligated volunteer reserve physicians⁴ (Table 2).

The intensity of the trauma experience during service in a theater of operations was remarked upon by all the presidents who served in such capacity. That experience is exemplified by my assignment as the Chief of Surgery

* The minutes of the AAST Executive session of June 6, 1942, record that the President-elect, 33 active fellows, and three honorary fellows were "in military service."

at the 12th Evacuation Hospital in Cu Chi, Republic of Vietnam. Cu Chi was the base camp of the 25th Infantry Division, which was continually active by virtue of our proximity to the Hobo Woods, the Iron Triangle, and the Michelin rubber plantation. Civilian casualties were also received and some of the care given these patients served as the basis for psychological warfare operations. Thousands of leaflets showing the author attending an injured Vietnamese child were scattered over Hau Nghia Province and succeeded only, he was told, in securing a place for him on the Viet Cong's "wanted" list. The intensity of combat activity resulted in a surgical workload that prevented boredom. The monthly reports of the 12th Evacuation Hospital surgical service for the last quarter of 1967 recorded 462 major operations in October, 417 in November, and 454 in December. One hundred seventy-seven celiotomies were performed, with involvement of the colon and rectum noted in 55 patients and of the liver in 42 patients (Table 3).

Surgical workloads of such magnitude quickly generated the experience that formed the basis of clinical reports subsequently presented at the meetings of this and other professional organizations. It also generated a certain cynicism on the part of the MASH and evacuation hospital surgeons when their treatment was questioned by surgeons remote from Vietnam. Criticism of our performance of an ileostomy and transverse colostomy instead of a primary anastomosis in a patient with extensive retroperitoneal tissue damage resulted in my formulation of the "Law of Combat Surgical Opinion Certainty," which, particularized for that time, stated that "The certainty of surgical opinion is directly proportional to the square of the distance of the opinion giver from Vietnam" (Fig. 3).

GENERAL FORM OF THE LAW OF
COMBAT SURGICAL OPINION CERTAINTY

"THE CERTAINTY OF SURGICAL OPINION IS DIRECTLY
PROPORTIONAL TO THE SQUARE OF THE DISTANCE
FROM THE SITE OF COMBAT"

Figure 3. General form of the Law of Combat Surgical Opinion Certainty.

The relationships with the military established by AAST members during World War II and subsequent conflicts have influenced successive generations of surgeons. I think it is no accident that Drs. P. William Curreri, Douglas W. Wilmore, James A. Long, and Cleon W. Goodwin came to the U.S. Army Institute of Surgical Research from the Department of Surgery of Drs. Ravdin, Rhoads, and Fitts or that Drs. Bruce G. MacMillan, Robert P. Hummel, J. Wesley Alexander, Jerry M. Shuck, and John L. Hunt all came to our Institute from the department chaired by Dr. William A.

Table 3
Surgical workload, October–December 1967, 12th Evacuation Hospital Cu Chi, RVN

	October	November	December
Minor operations	113	105	86
Major operations	462	417	454
Celiotomies	71	36	70
Colon & rectal injury	24	11	20
Liver injury	13	8	21

Altemeier, who served as a consultant to the U.S. Army Surgeon General. In similar fashion, Drs. William G. Cioffi and Theresa A. Graves were pointed in our direction by Dr. John "Hawkeye" Davis; Dr. William P. McManus was recommended for assignment at the Institute by Dr. Merle Musselman, a member of AAST who survived the Bataan Death March; and Drs. Charles R. Baxter, Peter C. Canizaro, and David M. Heimbach came to the Institute from the Department of Surgery chaired by Dr. G. Tom Shires, who served as a surgeon in the Korean conflict.

The lasting nature of the special Army Medical Corps-AAST relationship is evident in the area of surgical education. In recent years 11 U.S. Army surgeons have completed trauma surgery fellowships directed by officers and fellows of this organization.⁴ These trauma surgeons will provide "in-house" expertise and will possess the knowledge base to organize both peacetime and wartime trauma care.

The synergism generated by the relationship between the AAST and military medicine is amply evident in the annual programs of the Association. The peacetime advances in scientific understanding and technology made by both civilian and military investigators and reported at the annual meetings have been commonly applied to improve the care of patients injured in combat and, conversely, large-volume trauma care experience during wartime has validated new therapeutic and technologic developments that have thereafter become "standards of care" in the civilian sphere. Papers reporting advances in trauma care applied to or resulting from the care of casualties in the second World War and the conflicts in Korea and Vietnam have constituted a significant fraction of the scientific sessions of this Association. Those reports presented at the annual meetings of the AAST and, since 1961, published in the *Journal of Trauma*, have, in essence, defined the principles of wartime trauma surgery.

The programs of the first three meetings of the Association suggest that the founding members had premonitions of the world war in which the U.S. would soon be involved. Five papers describing the treatment of soft-tissue wounds were given. The recommended use of topical antiseptics in the treatment of open wounds presages the use of topical sulfonamides as a temporizing treatment of open wounds and later of burn wounds.⁵ The 16 papers on fractures in adults discuss the pros and

cons of balanced traction and the problems of intra-articular fractures, nonunion, and fat embolism. Four papers on tendon injury included Dr. Sterling Bunnell's review of his experience with the primary repair of severed tendons.⁶ Two papers discussed the treatment of abdominal injuries, and another the treatment of shock with cortical extracts.⁷

The fourth Annual Meeting was held at the Massachusetts General Hospital 6 months after the attack on Pearl Harbor. The program for that meeting contained papers on the problems of sulfonamide therapy, the treatment of fractures (five papers), the treatment of spinal cord injuries, craniocerebral wounds, intracranial hematomata, and frostbite in shipwrecked mariners, all of which would have application in casualty care during the war. A footnote in the program noted that "publication of the papers submitted by three men—since called to active service—may of necessity be delayed."⁸

There was no meeting in 1943, but in 1944 the transfer of information generated in the course of military service to the Association and the civilian community at large began. Three papers on fractures, one on spinal cord injuries, and one on penicillin therapy were either given or discussed by individuals for whom military rank is given. In addition, a military program occupied the morning of the second day and consisted of papers on the repair of cranial defects, rehabilitation, and additional papers on fractures.⁹ A similar military program was part of the next Annual Meeting, held in 1946. Ten papers were presented including "Traumatic Hemothorax" by Brian Blades, "Military Plastic Surgery" by James Barrett Brown, "Observations on the Management of Burns" and two papers on gas gangrene, one of which appears to anticipate hyperbaric oxygen therapy by proposing oxygen injection as a means of limiting spread of the infection. At that same meeting, a special program on aviation medicine was presented by the faculty of the U.S. Air Force School of Aviation Medicine, who discussed their studies of aircraft crash casualties and deceleration injury.¹⁰

At the 1948 meeting, another military symposium was presented as "a critique in the handling of traumatic cases in the past war." The five papers of the symposium covered injuries to peripheral nerves, the organization for handling trauma in the United States Navy, the transition in burn treatment that had occurred during the war, and observations on injuries from atomic warfare. The guest speaker at the annual dinner that year was Dr. Austin Brues, the Medical Director of the Argonne Medical Laboratory, whose topic was "Nature of Trauma in Atomic Warfare."¹¹ In 1949, the World War II experience was still being transferred as is evident in the paper on penetrating and perforating chest wounds presented by Dr. Vincent M. Iovine, which was "based on the experience achieved in a group of more than 1000 major chest wounds in the recent war." In that same year, Colonel Sam F. Seeley presented a paper entitled

"Intra-arterial Blood Transfusion" in which he discussed the development of the technique and reviewed the clinical results of intra-arterial blood transfusions. Dr. Truman G. Blocker and his wife, Virginia, presented a survey of 3000 casualties generated by the Texas City disaster in which they applied principles of triage based on the wartime experience. Another paper, entitled "Pertinent Factors Influencing Repair in Traumatic Wounds" included "an unreported follow-up study of 500 battle casualties in addition to a subsequent analysis of 721 traumatic wounds."¹²

Two days before the outbreak of the Korean conflict, Drs. Ravdin and Fitts presented, at the 1950 meeting, a paper entitled "The 'So-called' Blood Substitutes" in which they stated, "Following trauma in which whole blood is lost from the effective circulation, blood substitutes should be used only as a temporary measure until whole blood is obtained."¹³ During the Korean conflict, which extended over the next 3 years, that was the policy followed by United States forces.

The transfer of the experience gained in the Korean conflict to the Association and the surgical community at large began a mere 10 weeks after the Korean Armistice was signed, when Pulaski and Crosby presented a paper at the 1953 meeting of the Association entitled "Reaction of Battle Casualties to Massive Transfusion of Blood."¹⁴ They reported their experience with the successful resuscitation of casualties requiring 20 to 30 pints of blood over a period of 3 to 6 hours, presenting data on the rate of destruction of the red cells infused and the hematologic reactions of the patients. That experience was later published by Artz et al., and represents one of the earliest reports of coagulopathy in severely injured patients receiving massive transfusions.¹⁵ Isidore Ravdin, who then served as a consultant to the U.S. Army Surgeon General, presented a paper at the 1954 meeting entitled "Surgical Care in Major Catastrophes" in which he related the low mortality associated with wounding in action in Korea to five specific factors, i.e., the skills of fully trained surgeons, rapid evacuation by helicopter (a technology that came to full flower in Vietnam), the use of whole blood, the rapid application of research findings, as will be mentioned later, and the use of body armor.¹⁶

At the 1955 meeting, Curtis P. Artz, who became president of the Association in 1971, made a presentation in which he reviewed the military and civilian thinking concerning the treatment of mass casualties, noting both the similarities and the differences of the care provided in the two settings.¹⁷ At the 1956 meeting, a paper entitled "Infection—A Major Unsolved Problem in Severe Trauma" by C.P. Artz and P.E. Teschan and a paper entitled "Radiation Injuries—Notes on Hiroshima and Nagasaki" by Colonel Joseph R. Shaeffer essentially completed the presentation of papers about battle casualties in the Korean conflict and World War II, respectively. However, military medicine in peacetime was

given a special place on the program in the form of a symposium presented by the U.S. Air Force. The seven papers of that symposium focused on trauma incident to high-speed and high-altitude flying.¹⁸ In 1957 another special symposium entitled "Naval Medicine in Our Time" occupied one afternoon session of the meeting. Submarine and diving medicine were discussed in depth by four members of the U.S. Navy Medical Corps.¹⁹ At the 1958 meeting, John Howard reviewed the current status of Dextran as a plasma volume expander, anticipating by some 35 years the current renaissance of that material.²⁰

In the following year, 1959, a symposium entitled "Research in Trauma" by the Army Medical Corps was part of the annual meeting program. In that symposium, then Major Janice A. Mendelson reported on the work that she and Dr. Douglas Lindsey were doing on the use of topical sulfonamides as expedient treatment of open wounds. Major James C. Beyer reviewed the current status of wound ballistics research. Lieutenant Colonel Wilfred T. Tumbusch reviewed recent research in burns, and Lieutenant Colonel William H. Moncrief reviewed combined mechanical trauma and radiation injury. Douglas Lindsey also reported the results of his studies of the use of clostridial and staphylococcal toxoids to extend survival time following a massive experimental wound. Major Paul E. Teschan reported on current research in acute renal insufficiency, emphasizing the beneficial effects of the prophylactic hemodialysis regimen that he and Dr. Arthur D. Mason had developed to prevent and minimize the complications of uremia.²¹ Since the 1950s there have been no further military symposia as part of the annual meetings.*

In the succeeding interbellum years, civilian and military authors and investigators presented their work related to combat type injuries at the annual meetings. The information in these papers refined resuscitation regimens for patients with shock from blood loss,^{22,23} burn injury,^{24,25} and sepsis,²⁶ chronicled the continued development of topical chemotherapy for burns and other wounds,^{27,28} described the development and early use of biologic dressings,²⁹⁻³¹ and characterized the immune response to injury.³² In 1963, Colonel John A. Moncrief, who became President of the Association in 1974, identified pathogenetic factors important in the development of stress ulcers of the upper gastrointestinal tract.³³

In 1965, when Dr. Fitts was the President of the Association, Dr. John Howard presented a "Report from Vietnam" in the first year of what was to be an 8-year conflict.³⁴ In 1966, Colonel George Fisher reported on vascular injuries in Vietnam³⁵ and Dr. Robert Hardaway reported on the clinical investigations he had conducted in his special study unit at Walter Reed Army Medical Center.³⁶ That group was able to improve patient out-

come by the use of specific therapy to ameliorate the pathophysiologic consequences of shock. The 1967 program included a film in which General Leonard Heaton and General Sam Seeley described the care of war wounds in Vietnam.³⁷ That program also included a report on the anemia associated with sepsis in combat casualties.³⁸

In 1968, Dr. Norman Rich and Dr. Carl Hughes reported on the surgical pathological correlates of vascular injury in the 100 patients entered in the Vietnam Vascular Registry from whom the injured vessel was available for pathologic examination.³⁹ In that same year, hypoproteinemia and prolonged mechanical ventilation were related to the subsequent development of acute respiratory distress syndrome in shock patients by Hamit's group at the Walter Reed Shock Unit.⁴⁰ That same group documented platelet microaggregation as a component of the pulmonary changes associated with hypovolemic shock.⁴¹ Also in that year, Dr. Richard L. Simmons reported the results of studies, conducted when he was a member of the Walter Reed RVN Trauma Study Section, documenting the frequent occurrence and multiple causes of pulmonary edema in combat casualties.⁴² The U.S. Navy Research Institute personnel stationed at Da Nang simultaneously reported that large-volume resuscitation caused no significant hemodilution in 46 seriously wounded casualties.⁴³ The strikingly different incidence of pulmonary edema in those two studies may indicate that what came to be called Da Nang Lung was unrecognized in the northern part of South Vietnam.

In each of the next four annual meetings (1969-1972), the transfer of information gained by experience in Vietnam continued in the form of reports based on the Vietnam Vascular Registry, which by 1972 contained over 7500 patients. Dr. Norman Rich's reports reviewed the management of 1000 acute arterial injuries,⁴⁴ the outcome of patients who had fractures in association with their vascular injuries,⁴⁵ the high failure rate in the 1% of patients who had prosthetic vascular repairs (a finding that prompted a recommendation to avoid use of prosthetic material in contaminated war wounds),⁴⁶ and the long-term results in the 50 patients with subclavian artery injuries.⁴⁷ In 1973, the year after the Vietnam conflict ended, a report based on the registry recommended that, if at all possible, venous injuries of the lower extremities should be repaired.⁴⁸ At the 1974 meeting, the last report to this Association from the Vietnam Vascular Registry was made; Dr. Rich contrasted the amputation rate of limbs with common femoral artery trauma in Vietnam with that in prior conflicts and in civilian practice.⁴⁹

In 1975, the Association's global military connection was made obvious when Dr. Emil Blair sponsored a report describing the treatment and outcome of combat casualties in an Israeli evacuation hospital during the October 1973 Arab-Israeli conflict.⁵⁰ In 1990, the international status of the Association was further corroborated

* At the 1960 meeting a symposium on aerospace injuries was presented by invited physicians employed by aerospace companies.

rated by the report from the American University of Beirut Medical Center contrasting abdominal injuries from shell fragments with those from bullets.⁵¹

The tradition of prompt presentation of wartime experience to the membership was continued just this past year. Information about casualty care during Operation Desert Shield/Desert Storm was provided the Association at last year's meeting by the panel entitled "Trauma Preparedness for the Persian Gulf War"⁵² and in the form of a paper reviewing the planning for casualty management on a U.S. Navy hospital ship.⁵³

The annual programs of the AAST, during the 53 years of the Association's existence, have served as an effective two-way channel of communication between the military and civilian medical communities. Civilian and military investigators and authors have informed their peers of advances in scientific knowledge and technologic developments that have then been applied to improve combat casualty care in subsequent conflicts. Two thousand three hundred twenty six papers have been given at the 52 annual meetings of the Association since 1939. One hundred seventy seven, or one out of every 13 of those papers, have been given by military physicians or, in two instances, physicians who, recently returned to civilian practice, reported their wartime experience.* One hundred forty two (80%) of the papers given by military physicians were given by U.S. Army physicians and 73 (or 51%) of those were given by members of the U.S. Army Institute of Surgical Research (ISR).

Fifty-nine of the ISR papers were related to burns and that subset of papers constitutes 24% of the 244 papers on burn injury given before the Association. An additional 49 of the papers on burn injury were given by alumni of the Army's burn center, which, when combined with the other 59, represent almost half (44%) of the

AAST papers on burn injury (Table 4). These papers have described revolutionary changes in burn care that prevent the development of invasive burn wound sepsis and permit prompt closure of even the largest burn wounds, as well as evolutionary changes in resuscitation regimens that have essentially eliminated early organ failure⁵⁴⁻⁶⁰ (Fig. 4). The papers have also described alterations in thermoregulation and the hormonal environment that orchestrate postburn hypermetabolism,⁶¹⁻⁶³ defined the pathogenesis and effective prophylaxis of upper gastrointestinal stress ulcer disease,^{64,65} and have identified clinically important sequelae as well as effective means of diagnosing inhalation injury.^{66,67} This list encompasses just a few of the advances in combat casualty care reported at AAST meetings by our staff members that, in the aggregate, have significantly improved the outcome of burn patients.⁶⁸

The meetings have also provided positive feedback, whereby those who provided combat casualty care in each conflict could transfer that knowledge to the civilian community to enhance the care of civilian trauma patients. Advances in scientific understanding that were applied during World War II included prompt exploration of all penetrating wounds and the development of formulae to estimate the resuscitation fluid needs of burn patients.^{69,70} The technologic advances that improved World War II casualty care included plasma fractionation,⁷¹ the large-scale production of antibiotics,⁷² and the establishment of an effective system to provide large volumes of whole blood.⁷³ Experience in World War II defined the adjunctive role of antibiotics in the war wounded, demonstrated the usefulness of plasma fractions and whole blood, and confirmed the effectiveness of formula estimation of the fluid needs of burn patients in preventing acute renal failure.⁷³⁻⁷⁵

In the Korean conflict, primary vascular repair was undertaken for the first time,⁷⁶ as was the use of arterial

Table 4
Papers presented at AAST Annual Meetings 1939-1992

	Number (%)
Total papers	2326
Papers given by physicians in military service	
Army-Institute of Surgical Research	73
-Other Army units	69
Navy-Air Force-	25
Air Force-	10
Burn-related papers	
Total	244
Burn papers by U.S. Army Institute of Surgical Research	59 (24%)
Burn papers by U.S.A.I.S.R. plus U.S.A.I.S.R. alumni	108 (44%)

* There were an additional six papers read by title only (four by Army physicians, one by a Navy physician, and one by a member of the Canadian Army). One additional paper was read by title only reporting surgical experience during the Korean Conflict and one movie was presented by an Army physician in 1962.



Figure 4. The technique of tangential excision is used to remove burned tissue and effect early wound closure. When used on hand burns, as shown here, function is restored sooner. When used on burns involving other areas, burn wound excision limits infection risk and shortens hospital stay.

homografts.⁷⁷ As noted earlier, the latter represented a mixed blessing in light of the high subsequent failure rate of such implants in Vietnam patients.⁴⁶ The other technologic advance that improved casualty outcome in that conflict was the use of helicopters adapted for casualty movement.⁷⁸ In the Korean conflict, a Renal Insufficiency Center was established by a surgical research team that employed hemodialysis to reduce the morbidity and mortality of renal failure.⁷⁹

In the Vietnam conflict, the usefulness of aeromedical transfer of injured patients by helicopter was corroborated.⁸⁰ The average prehospital time for combat casualties treated at the U.S. Navy Hospital in Da Nang was only 80 minutes as reported by Cloutier et al. at our 1968 annual meeting.⁴³ The large volumes of crystalloid solution commonly used to effect hemodynamic resuscitation of severely injured patients in the Vietnam conflict clearly reduced the occurrence of acute renal failure.⁸¹ There appears to have been a "trade-off" of such therapy, however, since acute pulmonary failure and ARDS, called "Da Nang Lung" by some, became a frequent complication in critically ill combat casualties. That problem was addressed in a 1968 conference conducted by the Committee on Trauma of the Division of Medical Sciences, National Academy of Sciences—National Research Council, the proceedings of which were published by the *Journal of Trauma*.⁸² In Vietnam, the topical antimicrobial chemotherapeutic agent developed for burn wound care at the U.S. Army Institute of Surgical Research was first used in the theater of operations. Such treatment of burn wounds reduced the occurrence of invasive burn wound infections and increased the salvage of patients with combat-incurred burns.⁸³

Effective interaction between members of the American Association for the Surgery of Trauma and the military medical services has also been evident in clinical studies conducted in the theater of operations. The first example of such collaboration of which I am aware involved the third president of the Association, Fraser B. Gurd. His son, Fraser N. Gurd, who was the 28th President of the Association, has informed me that his father joined the Royal Army Medical Corps as a volunteer in World War I and, at the request of Sir Robert Jones, conducted an extensive review and study of the problem of chronic osteomyelitis.^{84,85}

That tradition was continued in World War II when Dr. Edward D. Churchill, serving as surgical consultant in the North African-Mediterranean theater of operations, identified the consequences of inadequately treated shock and was able to have a clinical research unit established in September 1944 to address that problem. The Board for the Study of the Severely Wounded, as that unit was named, conducted physiologic and biochemical studies focused on the whole body and organ-specific response to injury and shock. Results of those studies were published in *The Physiologic Effects of Wounds* a landmark volume of the series *Surgery in*

World War II published by the Office of The Surgeon General in 1952.⁸⁶ In the introduction to that volume, Dr. Churchill stated, "cobwebs of theory and hypothesis were swept away by simple observations and precise definitions." He identified three phases in the evolution of surgical knowledge during World War II: identification of the problem, development of practical treatment, and documentation by scientific evidence.⁸⁷ Those three phases characterize the process by which further improvements in combat casualty care have been effected since that time.

When describing the accomplishments of the unit that he fathered, Dr. Churchill was particularly proud of the fact that systematic and precise measurements were made that for the first time described the actual physiologic state of wounded man. It was such measurements that were responsible for subsequent improvements in care that increased survival of the severely wounded.⁸⁷

The Board for the Study of the Severely Wounded, which included surgeons (such as Dr. Fiorindo Simeone, a Fellow of the AAST now deceased), anesthesiologists, and pathologists, conducted a wide variety of physiologic studies of casualties during the 9 months in which the board was active. A system to grade shock was developed, the cardiovascular response to injury defined, the effect of injury on liver function illuminated, and the effect of injury on renal function studied to refine the diagnosis of renal failure and develop treatment of what was then called lower nephron nephrosis. The use of alkali in the treatment of shock was also evaluated, the crush syndrome studied, and the general pathology of traumatic shock recorded.⁸⁶

During the Korean conflict, Colonel William S. Stone, who had been instrumental in the formation of the Board for the Study of the Severely Wounded in World War II, played a similar role in the organization of the U.S. Army surgical research team on which Dr. John Howard represented Walter Reed and Dr. John H. Davis represented Brooke Army Medical Center. That team conducted physiologic and biochemical studies of combat casualties for whom they had provided initial surgical care. They measured total body water and documented that the relatively high incidence of acute renal failure in casualties at the beginning of the conflict was the result of inadequate fluid resuscitation. They initiated a program of hemodialysis using the artificial kidney developed by Dr. Wilhelm Kolff and quickly found that dialysis should be initiated as soon as serum potassium rose to 6 mEq/L to minimize hyperkalemia-related mortality.⁷⁹ That team identified the high-output form of acute renal failure⁸⁸ and conducted studies of vasodepressive and vasoexcitatory material (VDM and VEM). In the course of their surgical practice, "Hawkeye" Davis performed what I have been told was the first primary vascular repair in Korea. The success of that procedure prompted rapid procurement of vascular instruments for other United States military hospitals in South Korea.⁷⁶

Table 5
Mortality rates, U.S. Army casualties in 20th-century conflicts

Conflict	Colon Wounds (%)	Chest Wounds (%)
World War I	66.8	24.1
World War II	26.5	8.3
Korea	18.2	5.3
Vietnam	6.5	7.0

Adapted from: Thompson JC: The role of research in the surgery of tomorrow. *Am J Surg* 147:3, 1984⁹².

The tradition of theater of operations clinical investigations was continued in Vietnam. The Walter Reed Army Institute of Research Trauma Study Section stationed at Dong Tam and later moved to Long Binh was commanded by a succession of current and former fellows of the Association. Utilizing then state-of-the-art assays and technology, the team studied the physiologic changes that occurred following chest injury in combat casualties and the hemodynamic consequences of respiratory insufficiency following trauma.^{89,90} Other studies included those of gastric acid secretion and stress ulcers in combat casualties, the bacteriology of war wounds (an extension of earlier studies by the research team in Korea⁹¹), and a study of the effect of injury on serum levels of hepatic enzymes in combat casualties. The U.S. Navy had a similar research unit at the U.S. Navy Hospital in Da Nang and, as previously noted, both of the teams reported their findings at annual meetings of this Association and in the *Journal of Trauma*. The work of those teams has led to improved care for injured soldiers, which has been validated by the results obtained in civilian trauma patients⁹² (Table 5).

Unfortunately, this record of military-civilian interactions has not been well imprinted in the respective institutional memories (an amnesia that I hope to correct at least in part this morning). No provision was made for trauma study teams in the last three conflicts in which the U.S. Armed Forces have been engaged, i.e., Grenada, Panama, and Operation Desert Shield/Desert Storm. It seems possible that such sins of omission can be avoided if reserve units staffed by academic departments of surgery, as was the 20th General Hospital at which Bill Fitts worked, are again instituted and maintained in a state of sufficient readiness to respond to future conflicts. The surgeons of such units would have the capability to respond not only as citizen surgeons in the mold of Bill Fitts, but as citizen biomedical scientists in the mold of Drs. Churchill, Simeone, and Davis. Alternatively, the AAST should consider forming a Trauma Study Section as a Reserve Unit with a specific wartime mission of conducting clinical studies in order to meet new surgical challenges and maintain the Army-AAST synergy that has been of such benefit to all injured patients.

REFERENCES

1. Fromant RW, Savage JL, Lotze PE, et al: North Tirap log. In Stone JH (ed): *Crisis Fleeting*. Washington, D.C., Office of The Surgeon General, Department of the Army, 1969, footnote 25, 10
2. Hampton OP Jr, Fitts WT Jr: Fractures and dislocations. In Harkens HN, Moyer CA, Rhoads JE, et al (eds): *Surgery, Principles and Practice*, ed. 2. Philadelphia, J.B. Lippincott Co., 1961, pp 329-450
3. Minutes of first regular session of the First Annual Meeting of the American Association for Traumatic Surgery, May 8, 1939, Office of the Secretary, American Association for the Surgery of Trauma, Department of Surgery, University of North Carolina School of Medicine at Chapel Hill
4. Rodriguez A (Chief Surgical Consultant, U.S. Army Medical Corps): Personal communication, 1993
5. Estes WL Jr: The use of antiseptics in the treatment of open wounds. Presented at the second session of the First Annual Meeting of the American Association for Traumatic Surgery, May 8, 1939. Minutes of the First Annual Meeting of the American Association for Traumatic Surgery, Office of the Secretary, AAST, Department of Surgery, University of North Carolina Medical School at Chapel Hill
6. Bunnell S: Primary repair of severed tendons. Presented at the fourth session of the First Annual Meeting of the American Association for Traumatic Surgery, May 9, 1939. Minutes of the First Annual Meeting of the American Association for Traumatic Surgery, Office of the Secretary, AAST, Department of Surgery, University of North Carolina Medical School at Chapel Hill
7. Cole WH, Helfrich L, Cassels W: The prevention and treatment of shock with particular reference to corticoid extracts. Presented at the third session of the Third Annual Meeting of the American Association for the Surgery of Trauma, May 31, 1941. Minutes of the Third Annual Meeting of the American Association for the Surgery of Trauma, Office of the Secretary, AAST, Department of Surgery, University of North Carolina Medical School at Chapel Hill
8. Minutes of the Fourth Annual Session of the American Association for the Surgery of Trauma, 1942. Office of the Secretary, AAST, Department of Surgery, University of North Carolina Medical School at Chapel Hill
9. Scientific program of 1944 Annual Meeting of the American Association for the Surgery of Trauma. Office of the Secretary, American Association for the Surgery of Trauma, Department of Surgery, University of North Carolina Medical School at Chapel Hill
10. Scientific program of 1946 Annual Meeting of the American Association for the Surgery of Trauma. Office of the Secretary, American Association for the Surgery of Trauma, Department of Surgery, University of North Carolina Medical School at Chapel Hill
11. Scientific program of 1948 Annual Meeting of the American Association for the Surgery of Trauma. Office of the Secretary, American Association for the Surgery of Trauma, Department of Surgery, University of North Carolina Medical School at Chapel Hill
12. Scientific program of 1949 Annual Meeting of the American Association for the Surgery of Trauma. Office of the Secretary, American Association for the Surgery of Trauma, Department of Surgery, University of North Carolina Medical School at Chapel Hill
13. Ravdin IS, Fitts WT Jr: The "so-called" blood substitutes. Presented at 1950 Annual Meeting of the American Association for the Surgery of Trauma. Office of the Secretary, American Association for the Surgery of Trauma, Department of Surgery, University of North Carolina Medical School at Chapel Hill
14. Pulaski EJ, Crosby WH: Reaction of battle casualties to massive transfusion of blood. Presented at the 1953 Annual Meeting of the American Association for the Surgery of Trauma. Office of the Secretary, American Association for the Surgery of Trauma, Department of Surgery, University of North Carolina Medical School at Chapel Hill
15. Artz CP, Sako Y, Bronwell AW: Massive transfusion in the severely wounded. *Surgery* 37:469, 1955
16. Ravdin IS, Casberg MA: Surgical care in major catastrophes. Presented at 1954 Annual Meeting of the American Association

- for the Surgery of Trauma. Office of the Secretary, American Association for the Surgery of Trauma, Department of Surgery, University of North Carolina Medical School at Chapel Hill
17. Artz CP, Schaefer JR: The treatment of mass casualties. Presented at the 1955 Annual Meeting of the American Association for the Surgery of Trauma. Office of the Secretary, American Association for the Surgery of Trauma, Department of Surgery, University of North Carolina Medical School at Chapel Hill
 18. Scientific Program, 1956 Annual Meeting of the American Association for the Surgery of Trauma. Office of the Secretary, American Association for the Surgery of Trauma, Department of Surgery, University of North Carolina Medical School at Chapel Hill
 19. Scientific Program, 1957 Annual Meeting of the American Association for the Surgery of Trauma. Office of the Secretary, American Association for the Surgery of Trauma, Department of Surgery, University of North Carolina Medical School at Chapel Hill
 20. Howard JM, Ebert R: The current status of Dextran as a plasma volume expander. Presented at the 1958 Annual Meeting of the American Association for the Surgery of Trauma. Office of the Secretary, American Association for the Surgery of Trauma, Department of Surgery, University of North Carolina Medical School at Chapel Hill
 21. Symposium: Research in Trauma by the Army Medical Corps, Friday, September 25, 1959. Scientific Program, 1959 Annual Meeting of the American Association for the Surgery of Trauma. Office of the Secretary, American Association for the Surgery of Trauma, Department of Surgery, University of North Carolina Medical School at Chapel Hill
 22. McPherson RC, Haller JA Jr: The comparative effects of blood, saline, and low molecular dextran on irreversible hemorrhagic shock. *J Trauma* 4:414, 1964
 23. Drucker WR: Studies of lethal shock produced by vasopressors in normovolemic dogs. Presented at the 1963 Annual Meeting of the American Association for the Surgery of Trauma, San Francisco, California, October 25, 1963
 24. Hollis AU, Grozinger KH, Artz CP: The effects of low molecular dextran, urea, and mannitol on sodium and water retention in experimental burns. Presented at the 1963 Annual Meeting of the American Association for the Surgery of Trauma, San Francisco, California, October 25, 1963.
 25. Michie DD, Goldsmith RS, Mason AD Jr: A suggested mechanism for the pathogenesis of "burn shock." Presented at the 1963 Annual Meeting of the American Association for the Surgery of Trauma, San Francisco, California, October 25, 1963.
 26. Tumbusch WT, Vogel EH Jr, Butkiewicz JV, et al: Septicemia in burn injury. *J Trauma* 1:22, 1961
 27. Lindberg RB, Moncrief JA, Switzer WE, et al: The successful control of burn wound sepsis. *J Trauma* 5:601, 1965
 28. Mendelson JA, Lindsey D: Sulfamylon[®] (maphenide) and penicillin as expedient treatment of experimental massive open wounds with *C. perfringens* infection. *J Trauma* 2:239, 1962
 29. MacMillan BG: Homograft skin—A valuable adjunct to the treatment of thermal burns. *J Trauma* 2:130, 1962
 30. Haynes BW Jr: Skin homografts: A lifesaving measure in severely burned children. Presented at the 1962 Annual Meeting of the American Association for the Surgery of Trauma.
 31. Chardack WM, Day CE, Fazekas G, et al: Synthetic skin: An experimental study. *J Trauma* 1:54, 1961
 32. Feller I, Vial AB, Callahan WS: Human antibody response to active *Pseudomonas* infection and to a *Pseudomonas* vaccine. Presented at 1962 Annual Meeting of the American Association for the Surgery of Trauma.
 33. Moncrief JA, Switzer WE, Teplitz C: Curling's ulcer. *J Trauma* 4:481, 1964
 34. Howard JM, Reed JM: Report from Vietnam. *J Trauma* 6:268, 1966
 35. Fisher GW: Vascular injuries in Vietnam 1965-1966. Presented at the 1966 Annual Meeting of the American Association for the Surgery of Trauma, Santa Barbara, California, October 7, 1966
 36. Hardaway RM III, James PM Jr, Anderson RW, et al: Intensive study and treatment of shock in man. Presented at the 1966 Annual Meeting of the American Association for the Surgery of Trauma, Santa Barbara, California, October 7, 1966
 37. Heaton LD, Seeley SF: Army medicine in Vietnam (with particular reference to war wounds). Motion picture presented at the 1967 Annual Meeting of the American Association for the Surgery of Trauma, Chicago, Illinois, September 30, 1967
 38. Mahoney WD, Baugh JH, Hughes CW: Diagnosis and treatment of blood cell mass deficit secondary to trauma with superimposed infection. *J Trauma* 8:140, 1968
 39. Rich NM, Manion WC, Hughes CW: Surgical and pathological evaluation of vascular injuries in Vietnam. *J Trauma* 9:279, 1969
 40. Gutierrez VS, Berman IR, Soloway HB, et al: Relationship of hypoproteinemia and prolonged mechanical ventilation to the development of pulmonary insufficiency in shock. Presented at the 1968 Annual Meeting of the American Association for the Surgery of Trauma
 41. Allardice B, Hamit HF, Matsumoto T, et al: Pulmonary vascular changes in hypovolemic shock: Radiography of the pulmonary microcirculation and the possible role of platelet embolism in increasing vascular resistance. *J Trauma* 9:403, 1969
 42. Simmons RL, Heisterkamp CA III, Collins JA, et al: Acute pulmonary edema in battle casualties. *J Trauma* 9:760, 1969
 43. Cloutier CT, Lowery BD, Carey LC: The effect of hemodilutional resuscitation on serum protein levels in humans in hemorrhagic shock. *J Trauma* 9:514, 1969
 44. Rich NM, Baugh JH, Hughes CW: Acute arterial injuries in Vietnam: 1,000 cases. *J Trauma* 10:359, 1970
 45. Rich NM, Metz CW Jr, Hutton JE Jr, et al: Internal versus external fixation of fractures with concomitant vascular injuries in Vietnam. *J Trauma* 11:463, 1971
 46. Rich NM, Hughes CW: The fate of prosthetic material used to repair of vascular injuries in contaminated wounds. *J Trauma* 12:459, 1972
 47. Rich N, Jarstfer BS, Geer TM: Subclavian artery trauma. *J Trauma* 13:485, 1973
 48. Rich NM, Hobson RW II, Wright CB, et al: Repair of lower extremity venous trauma: A more aggressive approach required. *J Trauma* 14:639, 1974
 49. Rich NM, Hobson RW II, Fedde CW, et al: Acute common femoral arterial trauma. *J Trauma* 15:628, 1975
 50. Pfefferman R, Rozin RR, Durst AL, et al: Modern war surgery: Operations in an evacuation hospital during the October 1973 Arab-Israeli war. *J Trauma* 16:694, 1976
 51. Georgi B, Massad M, Obeid M: Ballistic trauma to the abdomen: Shell fragments versus bullets. *J Trauma* 31:711, 1991
 52. Trauma Preparedness for the Persian Gulf War. Panel presented at the 1991 Annual Meeting of the American Association for the Surgery of Trauma, Philadelphia, September 14, 1991
 53. Ochsner MG, Harviel JD, Stafford PW, et al: Development and organization for casualty management on a 1,000-bed hospital ship in the Persian Gulf. *J Trauma* 32:501, 1992
 54. Moncrief JA, Lindberg RB, Switzer WE, et al: The use of a topical sulfonamide in the control of burn wound sepsis. *J Trauma* 6:407, 1966
 55. McManus WF, Goodwin CW Jr, Mason AD Jr: Burn wound infection. *J Trauma* 21:753, 1981
 56. Petersen SR, Kravitz M, Umphred E, et al: The incidence of bacteremia following burn wound excision. *J Trauma* 22:274, 1982
 57. Snyder WH, Bowles BM, MacMillan BG: The use of expansion meshed grafts in the acute and reconstructive management of thermal injury: A clinical evaluation. *J Trauma* 10:740, 1970
 58. Switzer WE, Moncrief JA, Mills WJ, et al: The use of canine heterografts in the therapy of thermal injury. *J Trauma* 6:391, 1966
 59. Rue LW III, Cioffi WG, McManus WF, et al: Wound closure and outcome in extensively burned patients treated with autologous keratinocytes. *J Trauma*, in press
 60. Pruitt BA Jr, Mason AD Jr, Moncrief JA: Hemodynamic changes in the early postburn patient: The influence of fluid administration and of a vasodilator (hydralazine). *J Trauma* 11:36, 1971
 61. Wilmore DW, Orcutt TW, Mason AD Jr, et al: Alterations in hypothalamic function following thermal injury. *J Trauma* 15:697, 1975
 62. Vaughan GM, Becker RA, Allen JP, et al: Cortisol and corticotrophin in burned patients. *J Trauma* 22:263, 1982
 63. Shuck JM, Eaton P, Shuck LW, et al: Dynamics of insulin and glucagon secretions in severely burned patients. *J Trauma* 17:706, 1977

64. O'Neill JA Jr, Pruitt BA Jr, Moncrief JA, et al: Studies related to the pathogenesis of Curling's ulcer. *J Trauma* 7:275, 1967
65. McAlhaney JC Jr, Colmic L, Czaja AJ, et al: Antacid control of complications from acute gastroduodenal disease after burns. *J Trauma* 16:645, 1976
66. Pruitt BA Jr, DiVincenti FC, Mason AD Jr, et al: The occurrence and significance of pneumonia and other pulmonary complications in burned patients: Comparison of conventional and topical treatments. *J Trauma* 10:519, 1970
67. Hunt JL, Agee RN, Pruitt BA Jr: Fiberoptic bronchoscopy in acute inhalation injury. *J Trauma* 15:641, 1975
68. Pruitt BA Jr, Mason AD Jr, Goodwin CW: Epidemiology of burn injury and demography of burn care facilities. In Gann DS (ed): *Problems in General Surgery*, Vol. 7. Philadelphia, J.B. Lippincott, 1990, pp 235-251
69. Welch CE: War wounds of the abdomen. *N Engl J Med* 237:156, 1947
70. Cope O, Moore FD: The redistribution of body water and the fluid therapy of the burn patient. *Ann Surg* 126:1013 (footnote), 1947
71. Cohn EJ: The history of plasma fractionation. Chapter 28 in Andress EC, Bronk DW, Carden GA Jr, et al (eds): *Advances in Military Medicine*. Boston, Little, Brown & Co., 1948, pp 364
72. Keefer CS: Penicillin: A wartime achievement. In Andress EC, Bronk DW, Carden GA Jr, et al (eds): *Advances in Military Medicine*. Boston, Little, Brown & Co., 1948, pp 717-722
73. Hardaway RM III: Wartime treatment of shock. *Mil Med* 147:1011, 1982
74. Scott R: Military science and military surgery: The 1984 Fitts Lecture, A.A.S.T. *J Trauma* 24:553, 1984
75. Artz CP, Reiss E: *The Treatment of Burns*. Philadelphia, W. B. Saunders & Co., 1957, p 37
76. Davis JH: Personal communication, 1993
77. Spencer FC, Grewe RV: The management of arterial injuries in battle casualties. *Ann Surg* 141:303, 1955
78. Neel SH: Helicopter evacuation in Korea. *U.S. Armed Forces Med J* 6:691, 1955
79. Smith LH Jr, Post RS, Teschan PE, et al: Post-traumatic renal insufficiency in military casualties: II. Management, use of an artificial kidney, prognosis. *Am J Med* 18:187, 1955
80. Pruitt BA Jr, FitzGerald BE: A military perspective. In Bowers JZ, Purcell EF (eds): *Emergency Medical Service: Measures to Improve Care*. Port Washington, New York, Josiah Macy, Jr. Foundation, Independent Publishers Group, 1980, pp 223-244
81. Butkus DE: Post-traumatic acute renal failure in combat casualties: A historical review. *Mil Med* 149:117, 1984
82. Pulmonary effects of non-thoracic trauma. Proceedings of a conference conducted by the Committee on Trauma, Division of Medical Sciences, National Academy of Sciences—National Research Council. *J Trauma* 8:623, 1968
83. DiVincenti FC, Pruitt BA Jr, Moncrief JA, et al: Clinical Operation, Burn Center. In Annual Research Progress Report, US Army Institute of Surgical Research, Brooke Army Medical Center, Fort Sam Houston, TX, 30 June 1969, pp 1-ii-1-30
84. Gurd FN: Personal communication, 0000
85. Gurd FB: A contribution to the technique of infected wound closure, more especially compound fractures. *Lancet*, May 25, 1918, p 731
86. The Physiologic Effects of Wounds. Washington, D.C., The Board for the Study of the Severely Wounded, Medical Department, United States Army, Surgery in World War II, Office of The Surgeon General, 1952
87. Churchill ED: Introduction. In The Physiologic Effects of Wounds. Washington, D.C., The Board for the Study of the Severely Wounded, Medical Department, Surgery in World War II, Office of The Surgeon General, 1952, pp 1-20
88. Teschan PE, Post RS, Smith LH Jr, et al: Post-traumatic renal insufficiency in military casualties? I. Clinical characteristics. *Am J Med* 18:172, 1955
89. Moseley RV, Doty DB, Pruitt BA Jr: Physiologic changes following chest injury in combat casualties. *Surg Gynecol Obstet* 129:233, 1969
90. Doty DB, Moseley RV, Pruitt BA Jr: Hemodynamic consequences of respiratory insufficiency following trauma. *J Thorac Cardiovasc Surg* 58:374, 1969
91. Lindberg RB, Wetzler TF, Marshall JD, et al: Bacterial flora of battle wounds at the time of primary debridement. *Ann Surg* 141:369, 1955
92. Thompson JC: The role of research in the surgery of tomorrow. *Am J Surg* 147:2, 1984

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