A Band of Surgeons, a Long Healing Line: Development of Craniofacial Surgery in Response to Armed Conflict

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Abstract: Far removed from modern perceptions of cosmetic surgery, plastic and craniofacial surgery largely began centuries ago with efforts to redeem the destruction and loss from battlefield violence. Successive generations of surgeons responding with compassion to the functional and aesthetic loss of those wounded in war have achieved the progress that benefits 21st century patients. Although the historic role of war has to a degree been supplanted by jet travel, electronic communications, and academic medical centers, leadership continues to be the primary force responsible for advances. This article outlines the evolution of modern craniofacial surgery in 4 phases described by the Latin terms *pluresartes*, *pluresstelae*, *pluraloca*, and *pluresfontes*.

Key Words: Plastic surgery, craniofacial, maxillofacial, reconstruction, war, history, military, surgery

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The will to conquer is the first condition of victory.
Marshal Ferdinand Foch, Supreme Commander Allied Armies, WWI

There is much paradox inherent in plastic surgery, a field largely recognized by the modern public for aesthetics, belying its origin in violence. Specifically, craniofacial surgery had its genesis in the horrors of war, and the pioneers of the specialty, with few exceptions, made their seminal contributions caring for battlefield casualties. Their dedicated, compassionate leadership founded craniofacial surgery, just as practitioners today build upon their foundation to continue maturing the specialty in response to war. This article outlines the phases through which this process continues, emphasizing the importance of leadership to leverage emerging technology for the benefit of craniofacial patients.

BEFORE WORLD WAR I

Perhaps influenced by Homer's *Iliad*, which mentions 147 specific battlefield injuries (47 of the head and/or neck), Hippocrates wrote "he who would be a surgeon must go to war," yet his writings mention neither wound closure techniques beyond bandaging nor military casualties.[1,2] Nonetheless, sophisticated attempts at restoring form and function to intentionally injured faces were described by a near contemporary of Homer practicing in Kashi, India. Sushruta's regional flaps for nasal reconstruction (circa 600 BCE) are the first recorded plastic techniques, performed for nose amputations, which were a common penalty for Indian social infractions such as adultery.[1,3,4] More than half a millennium later, Celsus (25 BC to AD 50) described skin flaps for facial repair and other lesions in Roman soldiers, but concentrated efforts at facial surgery had to wait for Europe to emerge from the Dark Ages.[1]

Army surgeons led the way from the Renaissance onward. von Pfolspreundt and Brunschwig studied gunshot wounds and also rhinoplasty and cleft lips in the 15th century.[1,4] Ambroise Paré's watershed observations of wound healing in 1536 came directly from the battlefield in Turin.[4] Other military medical scientists began more exotic studies; van Meek'ren reported the use of a dog xenograft for a soldier's calvarial defect in 1682.[1] Garengot anecdotally replanted a soldier's nose in 1731.[5] Desault coined "débridement" in the 18th century as a result of managing battlefield wounds,[1,6] Across the pond, the first medical text in the New World was authored by American Revolutionary War surgeon John Jones.[1,4] Jones had acquired experience with combat injuries during the French and Indian War, and his book was essentially a field surgical and burn care manual, reprinted several times in 1776.[7]

Advances further accelerated in the 19th century in response to the increasingly destructive nature of war and concomitant emphasis on science. British surgeon Carpue introduced the Indian forehead flap to the Western hemisphere in 1814 in the care of an army officer's nasal reconstruction.[1,8] The same century, Dieffenbach, Estlander, Esser, and Joseph refined nasal, cheek, and lip reconstruction with attempts at pedicled tissue transfer[4,8] for military casualties. Although Reverdin conceived essentially modern skin grafting techniques, it was Ollier and Thiersch's duplicating and refining the procedure during the Franco Prussian War that led to its widespread adoption.[1,8,9] Bernard von Langenbeck's service in 4 wars led to multiple innovations. He first developed subperiosteal dissection techniques for maxillary and palatal trauma, then applied these to his eponymous cleft palate repair.[8,10]

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FIGURE 1. Patient of civil war surgeon Gurdon Buck.

Although the Civil War divided a nation, it brought together for the first time distinct medical specialties to collaborate on surgical care, a recurrent theme in plastic surgery. Union and Confederate surgeons alike leveraged the newly described technology of general anesthesia to complete more than 30 reconstructive procedures on the eyelids, the nose, the cheek, the lips, and the palate using rotational flaps, oral prostheses, and intermaxillary wiring; within a year of Appomattox, books were published on "reparative surgery," burns, and congenital anomalies (Fig. 1).[1,4,6,8,11,12]

With the cessation of the war, John Halstead returned to Baltimore after visiting premier European military surgeons such as von Langenbeck and began experimenting with forehead and cheek flaps and xenografting for oral and extremity injuries.[9] Shortly thereafter, Vilray Blair of St Louis, bored with teaching anatomy, volunteered as a ship surgeon for expeditions into the Amazon and Africa and learned about tropical diseases of the head and neck, then wrote *Surgery and Diseases of the Mouth and Jaws* in 1912.[13] His contributions would be unexpectedly relevant to thousands of young men 2 years later when Archduke Franz Ferdinand of Serbia was assassinated, drawing the West into the First World War (WWI) and Blair into a position of leadership along with a then unknown young otolaryngologist named Harold Gillies.

Despite these individual accomplishments, the comprehensive field of plastic surgery still did not exist.[14] Literature on complex wound care and surgery of the face and upper extremity was "confused in its principles, and though overflowing with diagrams and mathematical formulae, was rendered unconvincing by lack of systematic photographic recording."[15] Thus, on the eve of WWI, there was a "total ignorance of plastic surgery in the army… [and] even in civil hospitals of… 1917, the appreciation of this branch of surgery was also totally lacking."[13,14,16] This stage of development may be described by the Latin *pluresartes*, "multiple techniques" for wound management.

World War I

The harrowing experience of trench warfare disproportionately exposed the combatant's head and neck to high energy weapons, resulting in destructive facial wounds of unprecedented number and severity.[3] Initially, few surgeons were willing to take on the challenge, and none were certain how to manage them.[3,4,13,15]

Although the British had the most recent military experience from the Boer War (1899 1902), they were not prepared for the new patterns of injury, and in 1899 to 1902, UK medical manuals had "almost no value."[16] Out of desperation, masks were fabricated to hide deformities.[4]

The burden came to be shouldered by Harold Gillies, a burgeoning ears, nose, and throat specialist in England at the outbreak of the war without any previous experience in plastic surgery (Fig. 2).[13,14] In 1915, Gillies volunteered with the Red Cross to serve as a general surgeon in France where he met dentist Charles Valadier in Wimereux, France, learning principles of jaw injuries, possibly including bone grafting.[8,15,16] Months later, Gillies was presented a German book on facial surgery by American dentist "Bobs" Robert who had served in Paris. As Gillies recounts, "…it being a rather informal war, the enemy did not seem to mind our learning of the good work they were doing on jaw fractures and about the mouth."[11] He then followed Robert by traveling to Paris to learn from Hippolyte Morestin, an oral surgeon facile in emerging plastic surgery techniques such as flaps, serial excisions, and wide undermining to achieve skin closure.[3] He returned to the UK pressing for multidisciplinary care (surgeons, dentists, specialist anesthetists, and prosthodonists) for maxillofacial casualties.[8,11,16]

Gillies established the first military unit devoted to maxillofacial and plastic surgery cases in Aldershot,[8,11] which received 2000 facial casualties just from the first day of the Battle of the Somme.[15,16] His team tackled mandibular defects and massive wounds rarely if ever seen in civilian practice with bone and soft tissue from other regions of the body, a virtually unheard of practice at the time.[3,15]

Increasingly proficient with skin flap reconstruction, Gillies innovated with pedicled tube flaps[3,8,14,15,17] and described the principles of flap delay and techniques of free bone and cartilage grafts in nasal reconstruction.[3,15] Gillies pushed the envelope and had many surgical disasters, but his successes were spectacular. Importantly, he was gifted at pioneering technology, using the relatively the new technology of photography (Eastman invented the box camera in 1888) allowed him to publicize in Europe and the United States.[8] A separate advance that influenced medicine at large was the development of endotracheal anesthesia by Dr Ivan Magill,

FIGURE 2. Gillies in RAF uniform.

an anesthetist who conceived the technique to avoid problems with inhalational anesthesia, whereas Gillies worked on complex facial injuries.[17]

Direct US plastic surgical support of the war was led by Varistad Kazanjian who immigrated to the United States at the age of 16 years (Fig. 3).[18] After admission to Harvard Dental School in 1900, he gained attention by abandoning splinting in favor of sim pler wiring techniques.[13,18] Before the United States entered the war, he served as chief dental officer of the Harvard unit of the British expeditionary unit in France, earning the epithet "miracle man of the Western front,"[13,18] treating more than 3000 patients with wiring, bone grafting, and other avant garde techniques.[1,13,15,18]

Although Kazanjian made a tremendous individual impact, the US Army failed to anticipate the need for plastic surgery ini tially.[14] To meet the challenge, the army commissioned Major Vilray Blair to head the Section of Oral and Plastic Surgery, impressed by his 1912 text. Aided by Major Robert H. Ivy,[4,13,14] both men trav eled to England to learn from Gillies before undertaking full clinical responsibilities.[11,14]

The Aldershot unit moved to larger facilities in Sidcup in 1917 where friendly competition among the "colonial" teams from America, Canada, Australia, and New Zealand further raised stan dards while treating more than 11,000 patients.[4,14–16] The US Army units in France served largely to prepare maxillofacial casualties for evacuation to designated hospitals in the United States, a concept Blair borrowed from Gillies.[4,13–15] However, transport to def initive care took weeks to months, and severe facial deformity resulted from scarring of soft tissues, as they healed by secondary intention.

Gillies and Harvey Cushing pioneered by collaborating on complex cases during the war.[16] Cushing, already established in ac ademics as a neurosurgeon, created an American surgical team for head wounds near Ypres, which for 4 months, treated 250 injuries, developing innovative techniques such as debridement by suction and repair of dura with fascia lata.[16] Peripheral nerve study also advanced during this time by independent observations in France and Germany; the Hoffman Tinel sign is one of the results of such inquiry.[19]

John Staige Davis served in the US Army Medical Corps during WWI and argued that plastic surgeons manage all patients requiring complex reconstruction, regardless of the part of the body.[14,20] Although this would not happen until the next world war, the use of multiple tissues such as bone, fat, skin, and cartilage for facial injury was now largely accepted, establishing the second phase of reconstructive surgery *plurestelae*.

FIGURE 3. Kazanjian operating, WWI.

Interwar Years

After the Treaty of Versailles, countries were eager to down size their military forces and surgeons of that conflict readily returned to private practice. The advances of the war and the infrastructure of military medicine were largely abandoned, and no surgeon in either the army or the navy was trained for or maintained any special abili ties in plastic surgery.[14] However, the US National Research Council concurred on the importance of early treatment (and closure when possible) of facial injury, conservative debridement of face, avoid ance of removing bone fragments with soft tissue attachment, and early coverage of all extensive denudations by skin grafting or flaps.[14]

Dissemination of knowledge among civilians was primarily through informal observation of the best known practicioners,[13] so to organize and perpetuate interest, the American Association of Oral Surgeons was founded in 1921 (now the American Association of Plastic Surgeons),[11,13] and in 1931, the body now referred to as the American Society of Plastic and Reconstructive Surgeons was established.[11] In 1937, the American Board of Plastic Surgery was founded largely because of the drive of Vilray Blair to standardize the field.[13]

Blair had returned to St Louis as a civilian to lead academic plastic surgery, creating a center of excellence for cleft lip repair that endured for decades.[13] He trained numerous leaders such as James Barrett Brown, who first identified dermal adnexal structures as the source for donor site healing, accelerating the use of skin grafts.[13] Brown performed the first successful skin homotransplant between twins in 1937, paving the way for other plastic surgeons to achieve much in transplant surgery in later years.[13]

John Staige Davis was recruited by Halstead to come to Johns Hopkins and published the first modern American textbook in the field, *Plastic Surgery: Its Principles and Practice*, the year after the war ended,[5,13,20] then served as chair of the division until his death.[20] Halstead published his own results with vascularized bone and mus cle flaps, ulnar nerve release at the elbow, and his experiments with limb replantation in 1924.[9]

Varistad Kazanjian returned to Massachusetts and enrolled in Harvard Medical School to continue to be involved in the types of surgery he had performed in France. He graduated at 42 years of age[13,18] and served as professor of oral surgery there from 1922 to 1941, then became that institution's first professor of plastic surgery.[18]

Gillies found little interest in his work in Europe[15] and trav eled extensively throughout the United States, lecturing and visit ing leading surgeons, noting that in contrast to Europe, the field had passed from the empirical to a stage based on sound principles.[15] One of his post war protégés would, however, serve an important role in teaching the lessons of WWI to the next generation in both the United States and Europe John Marquis Converse.

Converse moved from the United States to France in 1915 when his father served in WWI and remained there through in ternship but chose to return to the United States for residency.[11,21] With family in Boston, he elected to train at Massachusetts General Hospital, having been introduced to Kazanjian through a wartime colleague of the professor.[21] Converse trained under Kazanjian at Massachusetts General Hospital and the Massachusetts Eye and Ear Infirmary through 1938,[21] then returned to Paris to work with prom inent surgeons including Gillies before moving to New York to es tablish himself, unaware that Nazi Germany's recent occupation of the Sudetenland would expand, eventually thrusting him into wartime service and leadership on 2 continents.[11,21]

World War II

Medical officers in World War II (WWII) leveraged several advances to improve patient care. Alexander Fleming had discov ered penicillin in 1928 and took an active role with surgeons such

as Gillies to establish guidance for management of infected wounds. Rapid evacuation by aircraft, development of blood banking and transfusion technology, and use of Magill technique of endotracheal intubation nearly doubled survival rates for combat wounds from WWI, making reconstruction of devastating wounds more feasible.[4,14,22]

British plastics units were established in advance of the war, planned by veterans Gillies, Mowlem, Kilner, and fresh, innovative young Archibald McIndoe, who was introduced to the field by his cousin Gillies in 1930 and took over his consultant position to the RAF in 1937.[4,15,16,23,24] The US Army also began activating university hospital units before entry into combat.[25] However, the tables of organization did not make adequate provisions for the speciality, and the Office of the Surgeon General did not include a plastic surgeon as a consultant.[14]

Fortunately, thereafter, surgeons recognized the need and selected Blair's protégé LTC J. Barrett Brown as a consultant for plastic and maxillofacial surgery and burns.[13,14] Brown and others visited the UK (including Gillies' unit at Basingstoke) and modeled their units accordingly, although they were inadequately prepared for the large volume of cases.[25] Like Blair, Brown arranged for definitive care of US maxillofacial casualties in designated army hospitals on American soil, each of which had a mean plastics census of 1000 to 1700 patients.[14] He served as the chief of the first and largest center, Valley Forge Hospital, in 1943.[13] Joseph Murray served under Brown at Valley Forge and became fascinated with skin grafting immunology, shaping his career and the future of the specialty.[13]

The Department of War made great efforts to standardize plastic surgical care from the outset. Within months of Pearl Harbor, the *Manual of Standard Practice of Plastic and Maxillofacial Surgery* was published and distributed under auspices of the Surgeons General of the Army and Navy.[26] Edited by veteran Robert Ivy, the text addressed surgical technique and priorities and military medical organization.[26] Initially, the army trained large numbers of small maxillofacial teams for far forward work,[4,14] but eventually, most of the work (after early closure of facial wounds) was done stateside by comparatively few trained general plastic surgeons with necessary equipment.[14]

The principles of reconstructive surgery would also take root in Europe because of the influence of John Marquis Converse. After training under Kazanjian, Converse spent several months with Gillies in 1939,[13] then volunteered with the Red Cross in France.[21] During German occupation, Converse retuned to England, visiting Gillies and McIndoe before returning to the United States in 1942.[21] The bilingual Converse was then tasked by the Department of State to go to North Africa to aid the French and Americans,[21] where an impressed General de Gaulle in turn asked him to organize a plastic surgery service in France.[13] By the end of the war, plastic surgery had taken the benefits of craniofacial surgery progress and expanded them to other parts of the body, most notably the hand, establishing the third phase of the discipline *pluraloca*.[27]

After WWII

The successes of wartime reconstruction, establishment of professional societies, and advances in anesthesia and antibiotics resulted in a public demand for maxillofacial surgery after WWII.[13,15]

In Britain, continuity in military and civilian surgeries was led by the dedicated service of McIndoe who continued to visit East Grinstead.[24] In addition to clinical work, he established a research unit at the Queen Victoria for wound healing and grafting.[24,28] In 1947, McIndoe was knighted and, in 1949, elected president of the British Association of Plastic Surgeons.[24] That year, struggling with the scope and practice of the nascent field, he wrote "It is not yet clear…what constitutes a plastic surgeon or even how he should be trained…no degree…advance claim for the establishment of a Faculty in Plastic Surgery under the aegis of the RCS."[24,29]

In the United States, similar tensions were felt, as returning surgeons who had observed and perhaps assisted in plastic surgery wanted to practice it in peacetime.[11] Again, John Marquis Converse helped lead and define the practice. In 1949, Converse published *Surgical Treatment of Facial Injuries* with Kazanjian, then established a major reconstructive center in New York.[11] He was elected president of the International Transplantation Society and created one of the first major research laboratories for transplantation biology.[11,13] This leadership is reflected in the original title of the specialty's flagship journal *Plastic, Reconstructive, and Transplant Surgery.* Such committed work in transplant biology by plastic surgeons in the 1950s was honored when Joseph Murray was later awarded the Nobel Prize.[13] In the 21st century, this technology would be reintroduced to craniofacial plastic surgeons as Maria Siemionow and others performed near total facial transplantation.

In the Korean War, lessons learned in wound management were forgotten, requiring the hiring of civilians, many of whom had served during WWII, as consultants to military hospitals.[30] Fortunately, that war also served as a catalyst for furthering craniofacial surgery's best known operation the cleft lip repair.

After his initial years of residency and a brief tour in the navy, D. Ralph Millard preceptored under Gillies and Kilner before pursuing additional training in St Louis.[31] After completion, he returned to Gillies in 1952 to begin collaborating on their classic *The Principles and Art of Plastic Surgery.*[13] Just as Blair had benefited from travel to Africa and South America, in 1954, Millard traveled with the 1st Marine Division to South Korea where cleft lips were more common and practice less restricted than in the United States (Fig. 4). There, he gained an epiphanous insight into repair and soon was operating on a series of Korean children before he reported his results the following year in Stockholm.[31]

Paul Tessier, "the father of craniofacial surgery,"[13] also benefited from wartime experience, learning under Converse in liberated WWII France, then with Gillies in the UK after the war.[13,21] Gillies had extrapolated his trauma experience to attempt to correct Crouzon syndrome deformities with Le Fort III osteotomies.[32] Tessier built upon this and, with the encouragement of neurosurgeon Gérard Guiot who had inherited principles established by Cushing in WWI, was able to successfully correct conditions such as hypertelorism and Crouzon syndrome.[16] Guiot's response to Tessier when asked about the feasibility of combining intracranial and extracranial approaches "pourquoi pas? [why not?]" was later adopted as the motto for the International Society of Craniofacial Surgeons.[33]

FIGURE 4. Millard in Korea.

During the same remarkable era, Ralph Buncke added microsurgery to the reconstructive surgeon's panoply, inspired by the insight of WWII veteran Thomas Gibson. Gibson had been a maxillofacial surgeon in the British Army before serving as editor of the *British Journal of Plastic Surgery* for a decade, publishing on a remarkably wide variety of topics sponsored by the British government.[34] Gibson mentored Peter Medawar, who was awarded the Nobel Prize in 1960 for immunologic tolerance,[21,34] as well as Buncke. In 1957, Gibson explained the important potential for microsurgery and tissue transplantation to Buncke, stimulating him to action.[13,34,35] Within a decade, the latter's success in microvascular tissue transfer in laboratory animals and humans helped usher in the age of free flaps, developed by civilian academic surgeons in several continents communicating by journals, personal correspondence, and jet travel.[36]

Global War on Terrorism

Owing to improved body armor and far forward surgical capabilities, Operation Iraqi Freedom (OIF) casualties have achieved overall 90% survival, the highest for any major conflict in US history.[37–39] Maxillofacial casualties in WWII had 40% mortality, whereas airway control, antibiotics, and early debridement reduced this to 1.3% by the Korean War.[40,41] The current US availability of neurosurgical, otolaryngological, plastic surgical, and vascular surgical expertise within hours of injury has lowered the rate to less than 1%.[40–42]

These statistics are particularly impressive given the volume and magnitude of injuries incurred. Up to 61% of Global War on Terror casualties have sustained injury to the head and/or neck areas left vulnerable by the otherwise remarkably effective body armor.[3,38,43]

The severity of injury produced by improvised explosive devices and rocket propelled grenades in close, urban combat has been documented by both US surgeons and clinicians native to the region.[44,45] Just as military and civilian neurologists hope to gain insight from the large number of closed head injuries in OIF, maxillofacial and plastic surgeons have the opportunity to help redeem losses through clinical advancements.[37–39,46–48]

Some areas have been revisited. The debate for surgery in theater or at home has been debated in both world wars and in recent conflict, partially because of the high rates of *Acetinobacter baumannii* infection in OIF casualties. Focused evaluation of facial fracture management determined that definitive management in theater posed no additional infectious risk, preventing complications from unnecessary delays in fracture fixation.[38] Similarly, the exact composition of multidisciplinary maxillofacial surgery teams continues to be contended, although the value of the availability of a broad range of expertise and experience for casualties is undeniable.[14,38]

It is unlikely that any new techniques for reconstructive surgery will be discovered or validated in the surgical tents of Iraq or Afghanistan. However, just as McIndoe, Gibson, and others with military experience worked in civilian laboratories with government projects in the areas of transplantation and immunology, for the next 5 years, the US Department of Defense will invest more than $250 million into 2 university led consortia comprising the new Armed Forces Institute of Regenerative Medicine to study and develop technology to advance wound healing, regenerate tissues, and facilitate complex reconstruction.[49,50]

The potential for regenerative medicine is significant, and reconstructive surgeons are in a position to lead this next evolution of the field to lead to a fourth stage *pluresfontes* tissue replaced from many sources (ie, transplanted or engineered tissue). Facial transplantation by Siemionow and others has already been mentioned, and the military has recently affirmed composite tissue allotransplantation through its firsthand transplantation performed 17 February 2010 at Lackland AFB, TX.[51] Although not yet standard care, the future possibility of induction of immunologic tolerance anticipates that such technology may eventually allow unprecedented reconstructive opportunities for composite bony and soft tissue maxillofacial trauma.

DISCUSSION

Before the advent of commercial aviation, widely circulated journals, and instant electronic communications, war brought the most passionate and skilled minds of the western world together to learn from each other. Moreover, the exigencies of war allowed governments to place together specialists from disparate fields to work on common goals. These functions of war have now been largely supplanted in a technologically shrunken world with established academic departments. However, the essential ingredients that established craniofacial surgery may still be found and are salient for any specialty.

By far, the most critical factor is leadership. John Staige Davis wrote "the story of plastic surgery is one of isolated peaks of accomplishment by a few individuals, connected by a slender threads [sic]."[1] In reality, the peaks have not been isolated and the slender threads more of a reinforced web, but the importance of a relatively few individuals cannot be disputed.

Dedication stands as the sine qua non of leadership. Generals Eisenhower and Marshall identified selflessness, and the courage to do what is right, as most important in selecting leaders.[52,53] Gillies' taking up of a new and difficult field with uncertain prospects for success and remaining directly involved in the care of soldiers for 2 world wars meets these criteria.

As one contemporary writer has noted, often "soldiers fight because their buddies fight. Heroism usually derives not from some deep heroic 'urge' or from the thoughts of Mom, apple pie, and national ideology, but from the example of others who are fighting."[54] Motivated by the sacrifice of thousands of young men in the 2 world wars, these leaders in turn inspired the cadre of a new specialty. This critical role of recruiting is highlighted in recent articles predicting future shortages in reconstructive surgeons in North America, a scenario that would directly impact a broad spectrum of other specialties dependent on such care.[55,56]

Effective leaders require creativity as well. Modern writers list 4 stages of creativity preparation, incubation, insight, and verification.[57] Preparation is a function of study and clinical exposure, the latter increased during war from large numbers of casualties. Incubation requires time, and longevity of any practitioner to see the same problems in multiple scenarios (ie, Gilles, Blair, and Ivy, serving in both WWI and WWII) yields benefits such as efficient guidance.

Insight often is the spontaneous connection from the prior 2 stages but may be catalyzed by a unique situation (ie, Millard's cleft lip repair during the Korean War). It can also be fostered by creating an environment that encourages innovation, particularly where multiple specialties interact intimately (eg, Aldershot under Gillies' supervision a leap facilitated by the demands of war and the organizational power and influence of central government).[58]

Verification, however, is likely the dominant role that war has played in developing reconstructive surgery. Flaps and grafts of various types and other techniques (ie, mandibular wiring) had been reported anecdotally before WWI. However, it was the large volume of cases handled by surgeons of multiple nations that verified in the medical community the safety and efficacy of these techniques.

Strategic leadership also requires surveying the environment for opportunities and technological advances. Gillies' exploitation of high quality photography and cross training with dentists, neurosurgeons, and anesthesiologists reflect adroit management of circumstances and resources. Tissue engineering and evolving concepts

in transplantation immunology likewise hold promise for modern surgeons.

Leaders also provide corporate memory. General David Petraeus recently commented that the Vietnam War was "fought nine times, a year at a time."[59] Efficient progress cannot afford to forget lessons already learned or fail to disseminate knowledge in a timely fashion. Much hard won maxillofacial knowledge was for gotten by some between WWI and WWII, and many WWII lessons were not initially applied in the Korean War. Retaining leaders with experience (Gillies, Blair, and Ivy, all contributed in both world wars) is an effective means to counteract intellectual entropy, even as their trainees (eg, Brown and others) develop new areas.

Finally, focused leadership is required to achieve vital in ternational and interinstitutional (government and academic) coop eration. John Converse's example of publishing, researching, and training of plastic surgeons in France and the United States both in military and academic settings shines as an enduring example. Today, the Department of Defense's investment in university based regenerative medicine research will hopefully yield significant clin ical benefits.

For any field to thrive, it must continue to take on new chal lenges based upon the informed vision of its leaders. For craniofacial surgery to continue to grow, to realize its full potential to restore form and function, its leaders must strive for success in all aspects (con genital, trauma, microsurgery, regenerative medicine, etc.), not just cosmetic surgery.

Fortunately, collaboration between the Department of De fense, pioneering universities, and industry continues to create pos sibilities for the future such as composite tissue allotransplantation and tissue engineering that our surgical forefathers would find as tounding. Such commitment will literally help fulfill a wartime pre sident's goal to "…bind up the nation's wounds, to care for him who shall have borne the battle," as well as continue to provide the highest quality care to persons of all walks of life.

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