

Prevention by Organization: The Story of No. 4 Maxillofacial Surgical Unit in North Africa and Italy during the Second World War

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Background: Written to commemorate the 60th anniversary of Victory in Europe, this article outlines the experience of No. 4 Maxillofacial Surgical Unit, stationed near Cassino, Italy, during the Allied assault in 1944.

Methods: Private archive material including the original data and case photography are used to illustrate the problems of severe maxillofacial injury and burns management in the theater of war. Trained by Harold Gillies, Patrick Clarkson was commanding medical officer of this small innovative unit. With his trainee Rex Lawrie, he overcame huge surgical challenges using the tool kit of wartime plastic surgery.

Results: Between 1942 and 1945, they managed 5000 casualties, including 3000 maxillofacial injuries and 1000 burns. To cope with such numbers, the Unit developed novel and aggressive strategies that opposed contemporary conservative practices. These included early primary closure of missile wounds to the face, which reduced union time for fractures and halved the number of late sequestrectomies. Early excision and skin grafting of large burns resulted in the successful management of burns of up to 72 percent body surface area, marking a shift toward the modern era of surgical burns excision. Cases presented include the first report of skin grafting to the calvarial diploe and a series of medullary bone grafts to restore frontal contour defects.

Conclusions: The drive to return injured men to duty without evacuation put great evolutionary pressure on the development of plastic surgery, and much is strikingly recognizable in current practice 60 years later. Were these early surgical lessons forgotten? (*Plast. Reconstr. Surg.* 121: 657, 2008.)

Patrick Clarkson practiced as a plastic surgeon in London from the Second World War until his death in 1969. This article describes the genesis of his career at a time when plastic surgery was young and those who practiced it had themselves been trained by surgeons of the late Victorian age.

Between 1942 and 1945, Clarkson (Fig. 1) found that the accepted methods of surgical practice available to him were out of sync with the problems that he was receiving from fierce mechanized combat in North Africa and Italy. Face and

jaw injuries were left open to “preserve the skin,” leading to chronic sequestering wounds and salivary fistulas. Burns were left to separate spontaneously, and only in the event that the patient survived long enough was skin grafting performed.

Clarkson’s unit, No. 4 Maxillofacial Surgical Unit, was stationed first in Algiers and then mobilized up the Italian peninsula as the 5th and 8th Armies drove the Nazis out. As officer in command, he faced the task of developing new and radical approaches to these problems. In so doing, he had to challenge the surgical culture of his era: He achieved this using evidence-based practice.

A pugnacious inter-London hospital heavyweight boxing champion, Clarkson was initially

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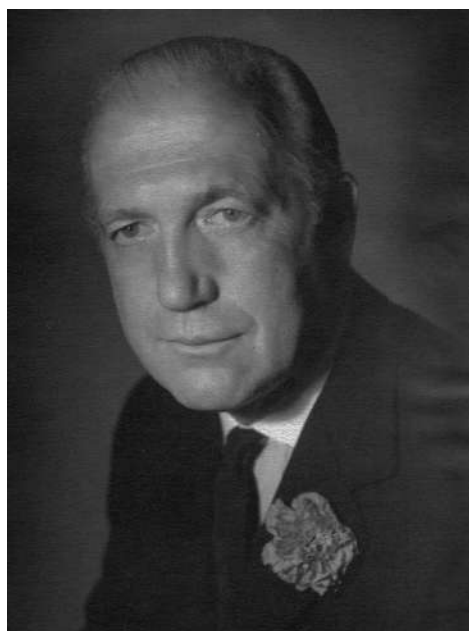


Fig. 1. Patrick Clarkson (1911 to 1969).

stationed in 1940 as a surgical specialist in northern France and was evacuated at Dunkirk. He then trained in the art of wartime plastic surgery, under Harold Gillies. A fellow New Zealander, he re-

mained a close confidant of his teacher long after the war had ended, and they shared surgical rooms in Harley Street, London.

At the start of World War II, Gillies set up eight mobile maxillofacial surgical units. Later in the war, an additional ad hoc unit was sent to Yugoslavia (Fig. 2). This article focuses on the experience of No. 4 Maxillofacial Surgical Unit in the Italian and North African theater of war, the crux of which were the bloody battles of Cassino.

Our sources consist of the original patient data, an album of wartime clinical photography and the war reports submitted to the Royal Army Medical Corps during the war from both Patrick Clarkson and his wartime trainee Rex Lawrie (senior author) (Fig. 3).¹ The first author is Clarkson's grandson; Clarkson died young at the age of 58, the year before the first author was born. We were stimulated to write about this wartime experience after the 60th anniversaries of the Battle of Cassino (2004) and Victory in Europe Day (2005).

The four battles of Cassino took place between January and May of 1944 and were some of the bloodiest of the Second World War, involving over 50,000 Allied casualties. Maxillofacial and burns trauma from the entire region drained to No. 4

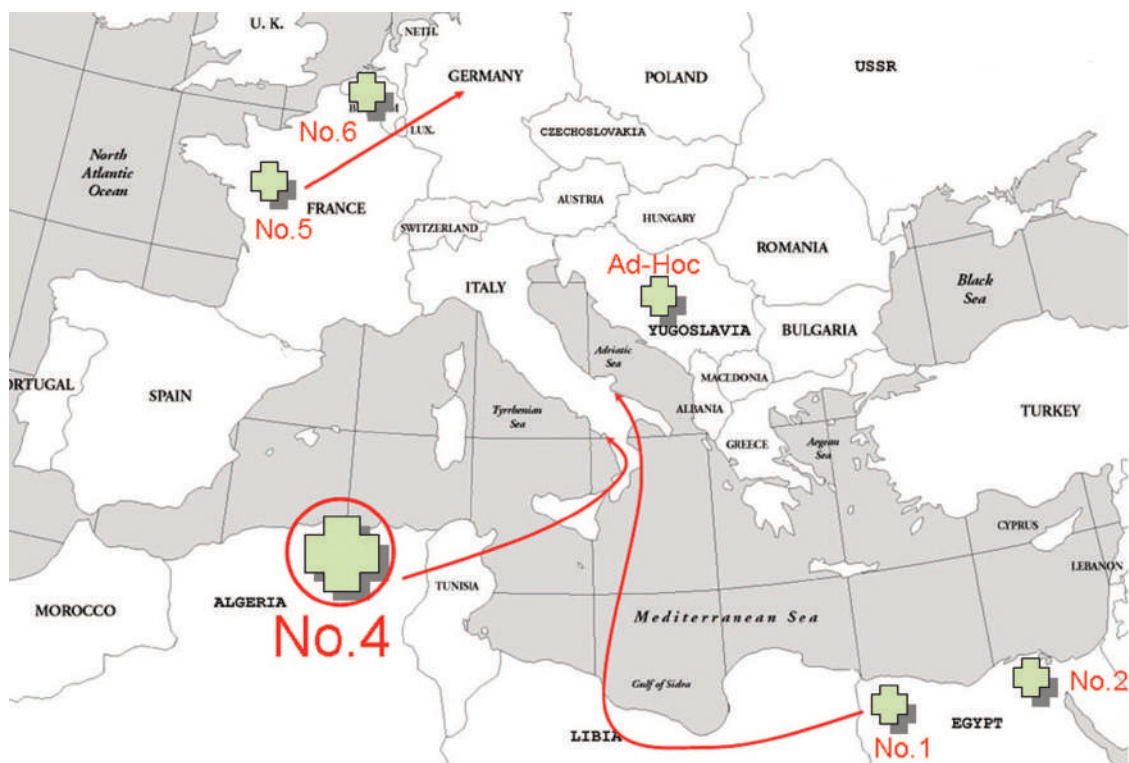


Fig. 2. The relative positions and movements of the maxillofacial units within Europe as the war proceeded. No. 4 Maxillofacial Surgical Unit is circled.



Fig. 3. Rex Lawrie (*center*) en route from Naples to Rome to retrieve a patient with a large burn, January 14, 1945.

Maxillofacial Surgical Unit. Interestingly, this also included the long-term complex cases from No.1 Maxillofacial Surgical Unit, on the east coast of Italy, run by Richard “Dickie” Battle, who went on to become president of the British Association of Plastic Surgeons, twice. (Battle favored more conservative and orthodox management strategies, in contrast to Clarkson.)

During the 2½-year period in Algiers and Italy, No. 4 Maxillofacial Surgical Unit treated nearly 5000 patients; 3000 cases were maxillofacial and 1000 were of burns; the remainder were of large chronic wounds and hand injuries. Clarkson made it his policy to keep the men until healed before returning them to active service and evacuated only 890 patients (approximately 20 percent) back to Britain for long-term rehabilitation or further surgery.

Despite the oppressively busy workload, the unit made every attempt to gather prospective data. They recorded up to 70 variables on the presenting features, management, and outcome of the burn or facial injury. Many of their original data have survived and display an earnest approach to answering the great surgical problems facing them. It allowed them to see the early trends that were needed to change their surgical practice and to prove that those changes worked.¹

The experience and case mix should be divided into two halves. During the first period, in Algiers, the unit experienced the management of long-neglected and late-presenting casualties from North Africa, including the great tank battles of El Alamein. The management strategies were

largely conservative during this period. Clarkson accounted for this as being attributable to the long lines of retreat in North Africa, and also the prevailing conservative surgical culture. In addition to this, however, they managed nearly 200 acute burns from naval catastrophes in the Mediterranean and also a number of acute maxillofacial injuries from terrorist-style antipersonnel devices in Algiers.

The improvement in outcome for those managed with early surgery became apparent, and the unit began to develop organizational strategies to achieve relatively early and aggressive management of these injuries. By the time they were mobilized to the Italian peninsula, they were able to follow these through. The Italian experience was a more immediate one, especially with the sudden rush of wounded from Monte Cassino to the unit stationed only 60 miles away in 65 General Hospital, Naples.

This provided two distinct historical cohorts for comparison: those with more traditional management in North Africa versus those managed using the new regimens in Cassino and Italy. The team was a small one, consisting of the commanding officer Major Patrick Clarkson, a graded surgeon Captain Rex Lawrie, and nine others (Table 1 and Fig. 4).

Lawrie describes how, on arrival in North Africa, “Clarkson transformed his unit from a team with a mere handful of instruments and subject to the demands of the general surgeons into an independent unit with its own trained staff, its own wards and operating theatre and equipment.”

Table 1. Members of No. 4 Maxillofacial Surgical Unit

Commanding officer	Major P. Clarkson
Training surgical specialist	Captain R. Lawrie
Maxillofacial graded surgeon	Captin W. Grossman
Dental specialists	J. Hancock and Major Wilson
Anesthetists	Major G. T. Roch and Captain Clynick
Dental mechanics	Sergeant Pery and Sergeant Jackson
Scrub nurse	Sister Pauline Clutton
Ward sister	Sister Bobby Costello

They worked at times with an inpatient commitment of up to 300, and an average of 60 operating theater hours per week, which could be “round the clock” during battle. Clarkson reports that, during the battle of Cassino, “theatre staff had to work 20 hours a day . . . to provide the service.”

According to Rex Lawrie in the forward unit, the dentist “unfortunately went mad and had to be shipped off!” It was in this atmosphere that modern organizational strategies evolved in that cauldron of conflict.

MAXILLOFACIAL CASUALTIES

Clarkson states that the Unit’s first duty was to return personnel to the front line with as much efficiency as possible. In North Africa, they found that the maxillofacial case load at admission to the unit had largely been managed elsewhere by conservative surgical debridement alone and left open to drain. These cases were hard to turn around quickly, often requiring multiple operations and sequestrectomies before the cancellous chip bone grafting could safely be performed.

Clarkson expressed exasperation with a surgical discipline that could lead to this impasse:

The official policy with facial wounds continued to be to leave them open to heal in deformity, and then later to do scar correction. The clinical dictum that facial skin was utterly precious and that not a millimetre of it should be killed at primary treatment was firmly established.

From the Unit’s experience with more acutely managed local shrapnel injuries from Algiers, they observed that early primary closure of facial wounds by wound edge excision led to not only faster healing but also faster union of underlying fractures. Crucially, it decreased the time delay until subsequent bone grafting could be performed. They were not able to implement this strategy until they had control of the initial phases of management.

In an attempt to achieve this in North Africa, Clarkson sent a roving forward section to the front line casualty clearing stations at Souk Ahras; however, because of an equipment shortage, its role was limited to dental fixation. Clarkson claimed that this was the first such forward unit used in the war and that its usefulness provided support for specialist forward surgical units to be made available later in the war.

This policy was fully implemented in Italy when the Unit was split into a forward section and a rear section in January of 1944. It was here that true multidisciplinary teamwork first evolved. Maxillofacial-plastics, ophthalmology, and neuro-



Fig. 4. No. 4 Maxillofacial Surgical Unit operating in Naples. 1, Patrick Clarkson; 2, Captain Clynick (anesthetics); 3, Sister Clutton; 4, Richard Battle (visiting). The photograph was taken by Rex Lawrie.

surgery were placed together in the management of complex head and face injuries, close to the front. They became known as “the trinity.” Clarkson admitted that the neurosurgeons were more use to him than he was to them, with 15 percent of maxillofacial injuries involving brain, though he managed the skull defects and denuded outer tables.

Beyond the common sense of this arrangement, they were primarily forced together by the need for a specialized anesthetist for these difficult cases, which reduced mortality resulting from maxillofacial injuries in No. 4 from 10 percent to 0.5 percent. Clarkson writes:

The risks of treatment can be greater than the risks of injury in inexperienced hands; this applies especially to the anesthetic risks . . . The use of the trinity was first developed in Italy. From the experience of earlier campaigns . . . [it is] . . . more successful and more happy than ever before in this war and that this was chiefly the result of splitting the special units into forward and main sections, and of keeping the forward sections as a trinity, and well forward.

The forward section, led by the trainee surgical specialist Rex Lawrie, was responsible for the early primary closure of facial wounds after debridement of obviously dead underlying bone. It was staffed interchangeably from the rear base unit by air transport, allowing for follow-up of cases and centralized supervision of the acute treatment from the battlefield through to later treatment at base. Rex Lawrie informs me that he was able to get on a military aircraft at short notice to return to base for advice or follow-up and be back at the front by evening.

In the 8 weeks during the battles of Cassino, he treated 379 cases. Ninety-five percent of patients with simple soft-tissue injuries and 60 percent of patients with compound injuries involving antra or buccopharyngeal regions were returned to duty after 11 days. The remainder were sent back to base in Naples. Early primary closure was performed with deep 6-0 catgut and interrupted superficial fine silk that was removed between the second and fourth days. Intermaxillary wiring was provided for fracture stabilization, leaving bone gaps if necessary for later bone grafting once healed.²

Rex Lawrie writes in his contemporary report: “Most of these cases here reported were operated on in a tented theatre, without using gowns or gloves; . . . despite this sepsis has been conspicuously absent.” On analysis of his figures, of 379

cases, there were five acute infections that returned to him and six late infections that developed in the rear unit, giving an infection rate of 3 percent.

The Unit’s catch phrase according to Lawrie was “prevention by Organisation”; Clarkson’s aim was to prevent the development of maxillofacial sepsis by early primary debridement and closure. He reports that the patient’s management needed to be “geared to a timetable” of early debridement and closure with bone grafting between 1 and 4 weeks after primary healing.

Once healing had been achieved, more complex reconstruction was possible. This included scar correction and pinna reconstruction (Fig. 5). He also managed salivary fistulas and soft-tissue loss to the face with tube pedicles. Eyelids were reconstructed with temporal flaps (Fig. 6).

The rear section replaced intermaxillary wires with splinting and fixation of varying types (Table 2), including head caps (Fig. 7).

Despite the presence of a forward unit, No. 1 Maxillofacial Surgical Unit, run by Battle, did not adopt the stance taken by No. 4 Maxillofacial Surgical Unit, only closing 60 percent of their faces primarily, preferring to manage the rest by a combination of loose apposition and open drainage in accordance with received wisdom.³

By the end of the war, No. 4 Maxillofacial Surgical Unit had gathered enough data to prove their case.^{4,5} When they compared mandibular fractures managed by delayed closure after sequestrectomy (received both in North



Fig. 5. Pinna reconstruction.



Fig. 6. Eyelid reconstruction for a prosthetic globe with a temporal flap.

Table 2. Methods of Facial Fracture Stabilization Used by the Unit*

Method	No.
Cast metal splints	397
Dental wiring	500
Perialveolar and circumferential wires	45
Interosseous wires	1
Roger Anderson extraoral pins	15
POP head caps and external rod fixation	38

POP, plaster of paris.

*Data from Clarkson, P. Treatment of 1000 jaw fractures. *RAMC War Report*, 1945.



Fig. 7. Plaster head cap for controlling floating maxillary blocks.

Africa and later still from No. 1 Maxillofacial Surgical Unit) versus those cases managed from the start by early primary closure, they found a considerable reduction in union time and the number of operations required for reconstruction (Table 3). Clarkson reported that, after implementing this policy, the sequestration rate dropped by 60 percent, falling eventually to only 10 percent of all jaw wounds showing evidence of infection.

Twenty-six of the 220 brain injuries reaching the multidisciplinary trinity team were treated for skull defects over 5 months⁶ by Clarkson and Major K. Tutton, of No. 5 Neurosurgical Unit. Although both acrylic and tantalum plates were available, for calvarial defects Clarkson exclusively used medullary bone chips from the ilium (Fig. 8), reserving tantalum for orbital reconstruction. All grafts were performed between 7 and 19 weeks after injury, 80 percent of which were for frontal defects. The largest defect in the series was 150 cm² and involved the simultaneous movement of a large calvarial fragment into the frontal region (Fig. 9). Access was gained by means of bitemporal "Soutar flaps." Medullary chips were taken from a 5-cm incision 3 cm below the anterior iliac crest, with preservation of the outer cortex to maintain contour. In an effort to reduce the effect of bone resorption, the defects were packed with 20 percent more volume than required. He reports that 16

Table 3. Early Primary Closure of Missile Wounds to the Jaws*

	Early Closure (primary treatment by No. 4 Maxillofacial Unit)	Late Closure (from elsewhere)
Total no.	135	146
Average union time, days	56	70
Bone gaps	27	25
Late sequestrectomy	41 (52 operations)	92 (136 operations)

*Data from Clarkson, P. Treatment of 1000 jaw fractures. *RAMC War Report*, 1945.

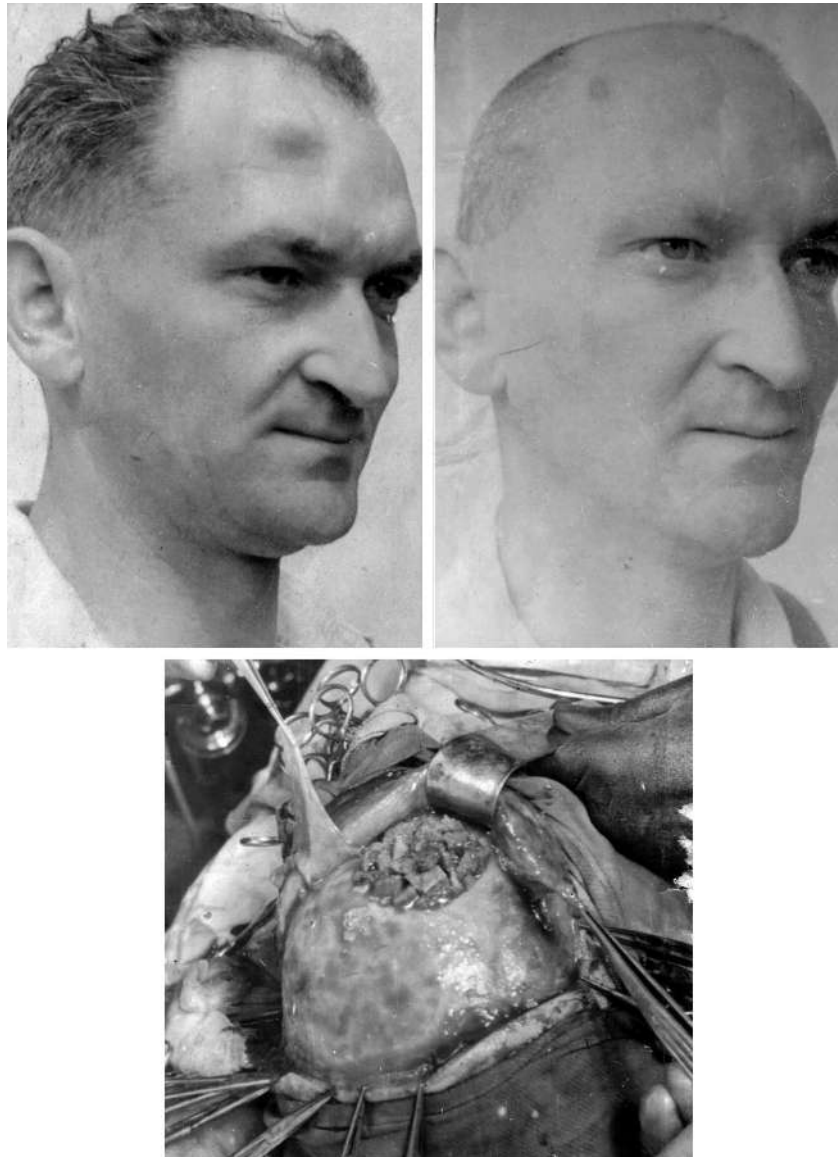


Fig. 8. (Above) This U.S. army soldier reported sick 6 months after management by U.S. neurosurgeons because he "did not like being under fire without proper cover to his brain." (Below) The bitemporal Soutar flap and pericranial flaps are raised with the medullary bone chips in situ.

cases achieved good symmetrical contour, though eight others developed some late resorption. Of those 26 cases, 16 returned to duty in the Mediterranean.

BURNS MANAGEMENT

Making use of the same method of prospective data collection, Clarkson and Lawrie were soon able to see the advantages of early excision of

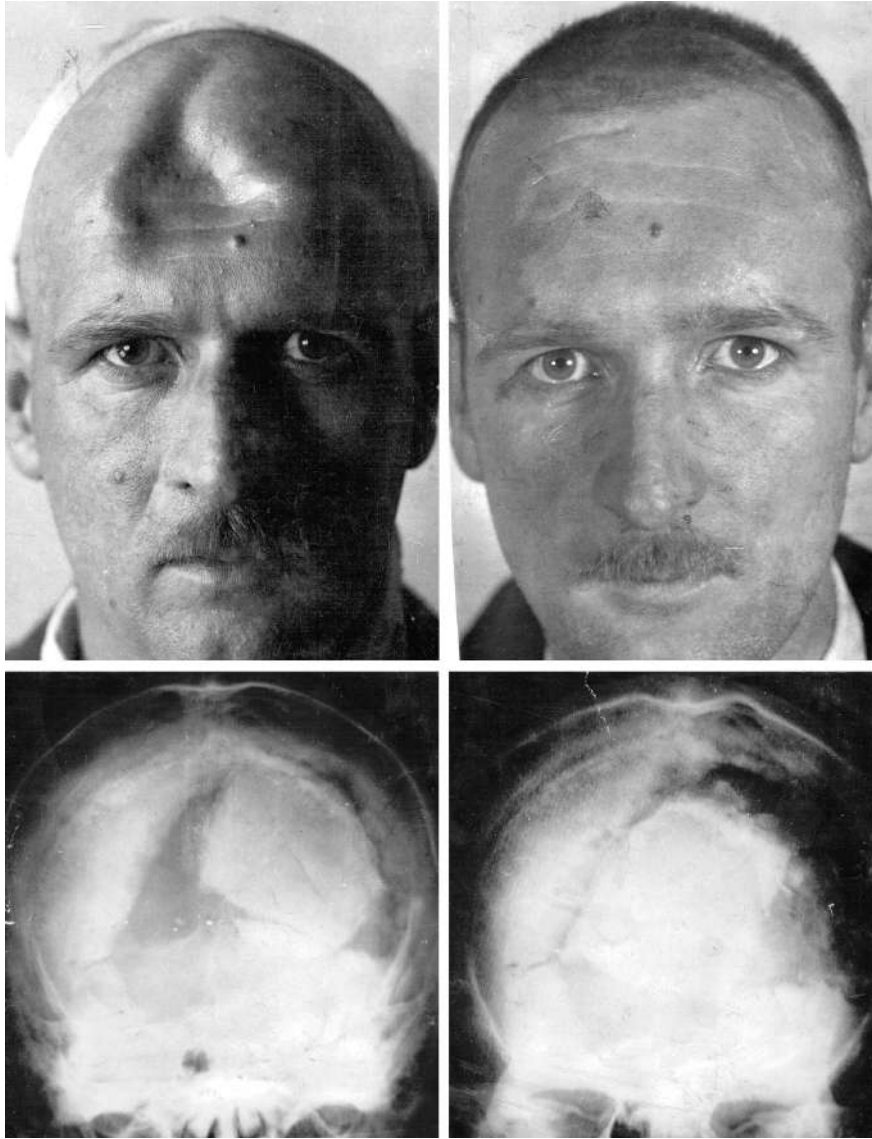


Fig. 9. Images demonstrating frontal remodeling. This patient had a 6×8 -cm fragment mobilized and brought forward, fixed in place by iliac bone pegs, and the residual defect filled with medullary chips. He was mobile in 2 weeks and evacuated to the United Kingdom by troop ship.

burns. Once again, in Algiers, they experienced the result of conservative burns management. They saw a clear difference when they managed the burns from day 1. This led to a structured program of early burns debridement and grafting that was implemented fully during the subsequent advance up Italy.^{7,8} This was in the face of the orthodox conservative burns management strategy of the time.

The prospective data produced the first “burns mortality” curve with its distinctive S shape, published in their article in 1946 and later quoted by Bull and Squire in their analysis of burns survival

in 1949.⁹ It also demonstrated the effectiveness of penicillin in increasing the rate of skin graft healing (Table 4).

They successfully managed some very large burns, including a group of 24 Italian prisoners of war with 50 to 72 percent total body surface area burns, who survived. We have established survival figures from their original handwritten data on 192 skin-grafted patients (Fig. 10). They had only nine deaths in 800 cases (Table 5).

Their success was helped by the Unit’s uniquely good anesthetic cover to deal with the head injuries treated by the trinity. Using intravenous pentothal

Table 4. Effect of Penicillin on Time for Skin Graft Take

	Burn Area				
	0-99 cm ²	100-299 cm ²	300-499 cm ²	500-999 cm ²	>1000 cm ²
Penicillin, days	16	15	25	16	30
Nil, days	21	20	35	29	27

(thiopentone), anesthesia was becoming recognizably modern and blood products were available for transfusion. Penicillin was provided in 1943 on a visit to the Unit by Howard Florey, who produced a box, Lawrie recalls, of small vials of brown powder. However, most of all, it was Clarkson and Lawrie’s methodology in seeing the early effects of their strategies through their prospective audit that provided the key to their progress.

In 1944, to recover from infective jaundice in what was now Allied-controlled southern Italy, Sir Archibald McIndoe visited No. 4 Maxillofacial Surgical Unit in Naples (Fig. 11). No doubt McIndoe imparted his pearls of wisdom, but the new early timetable for excision and grafting had already been initiated. With characteristic clarity, Clarkson was somewhat scathing of current surgical practice:

Much of the confusion of thought that envelops the subject of healing of burns arises from a failure to make the critical diagnosis between burns involving partial skin thickness and those with destruction of the whole thickness of the skin . . . it must be clearly realised that an indecisive expectant policy in these

cases delays healing inexcusably and often causes . . . death.

Clarkson and Lawrie demonstrated that although the healing time bore little relationship to the size of the burn, it was quicker in those grafted in less than 5 weeks. This paradigm shift allowed him to turn his cases around faster with a program of surgical eschar excision at 12 to 18 days followed within 48 hours by split skin grafting. For the first time, burns were managed according to a timetable of excision and grafting, aiming for complete healing by 5 weeks. Lawrie recalls:

One of the most time consuming procedures was the application of “postage-stamp” split skin grafts to resurface large areas of granulating burns. Toward the end of one such operation I can still hear her [Pauline Clutton] saying “six hundred and forty-eight.” With very large areas, for speed we might have two people applying the grafts and one cutting up the skin, or which ever combination was quickest [Figs. 12 and 13].

The split skin graft was harvested with a Padgett dermatome and Blare knife, and in difficult areas the patches were glued on using gum acacia. No. 1 Maxillofacial Surgical Unit, run by Battle, did not possess these knives, and all their large burns were referred to No. 4 in Naples.

The burns images include the first reported case of grafting to the inner table of the skull following electrical burns. This was removed by gouging to expose the diploe, which could then be grafted (Fig. 14).

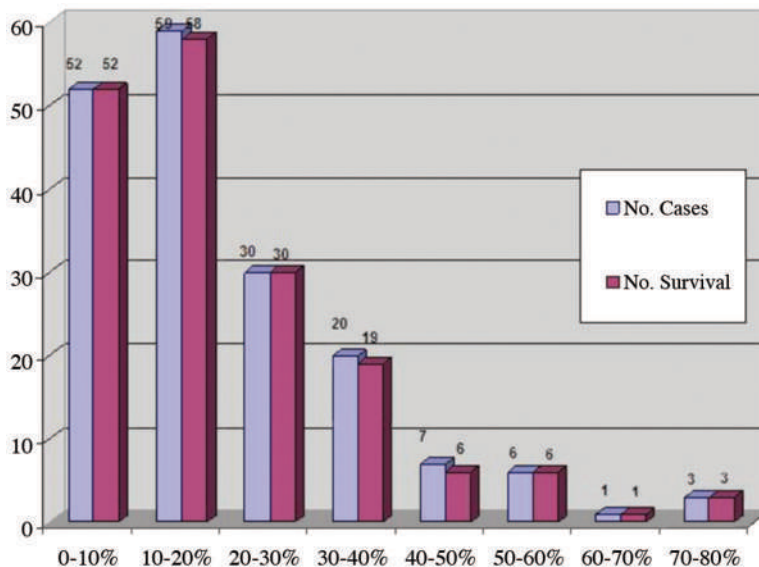


Fig. 10. Burns survival in 192 skin-grafted cases.

Table 5. Nine Deaths in 800 Burns

Cause of Burn	% Burn	Split Skin Grafting	Day Admitted	Day Died	Cause of Death
Tank	40	Yes	9	42	Friedlander pneumonia/blast lung
Tank	40	Yes	27	40	Prolonged anaesthesia
Air crash	10	Yes	38	49	<i>Staphylococcus aureus</i> pyemia
Phosphorous	40	No	2	8	<i>Staphylococcus aureus</i>
Cordite	40	No	6	21	Prostatic and pulmonary abscess
Cordite	15	No	5	11	Thyroid and pulmonary abscess
Tank	35	No	8	8	Shock
Tank	35	No	8	8	Shock
Cordite	40	No	1	8	Adrenal hemorrhage

**Fig. 11.** Patrick Clarkson and Sir Archibald McIndoe in Naples, 1944.

Clarkson paid particular attention to the management of hand burns, using a two-stage reconstruction policy. Early escharectomy and split skin grafting was performed, followed when healed by contracture release and full-thickness skin graft inlays with early physiotherapy 7 days after surgery.

His attention to nutrition was forward thinking, if not somewhat wishful: "As soon as they can take it, the patient is put on a special high protein, high sulphur, high calorie diet, consisting largely of steak and eggs, champagne, brandy, and ice cream." This was a diet that he later became fond of himself and that may have contributed to his early demise at the age of 58 from multiple strokes. Known for his dry "puckish" sense of humor, he would have enjoyed the irony.

DISCUSSION

In the Mediterranean theater of World War II, Patrick Clarkson was young, well trained, and, perhaps crucially, relatively unsupervised and so not subject to stifling pressures from on high. His circumstances further helped him by bringing him

into contact with American surgeons stationed in North Africa and Italy, for whom he held a very high regard. In particular, he acknowledges the help and support of Colonel Edward Churchill of Massachusetts General Hospital. Others included Samuel Balkin, who later became president of the American Society of Maxillofacial Surgeons (Table 6).

This series closely resembles modern "multidisciplinary practice," with centralized management and standardized treatment regimens using evidence-based practice. To many, it may come as a surprise that such a level of organization had been acquired by the 1940s, especially because it is mirrored by "modern" trends in the twenty-first century.

Has this work been forgotten? It would appear that medical history, unlike military history, is written not by the victors but by the survivors. The only modern published account of Maxillofacial Surgical Unit activity within the Mediterranean described the experience of the ex-president of the British Association of Plastic Surgeons, Richard Battle, without reference to No. 4 Maxillofacial

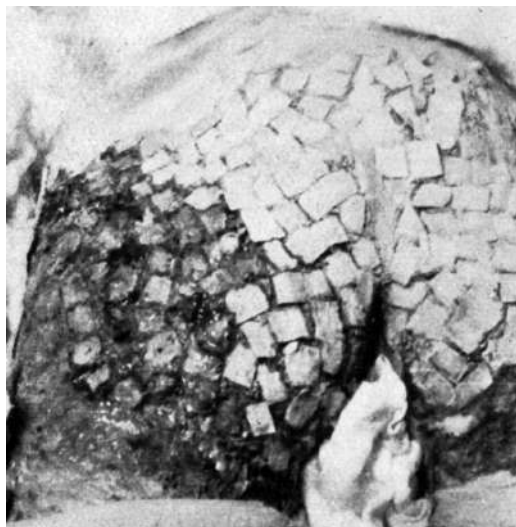


Fig. 12. Patch grafting in a case of 70 percent burns managed successfully to healing. (Reproduced from Clarkson, P., and Lawrie, R. S. The management and surgical resurfacing of serious burns. *Br. J. Surg.* 33: 311, 1946. Permission is granted by John Wiley & Sons, Ltd., on behalf of the British Journal of Surgery, Ltd.)



Fig. 14. The first recorded case of grafting to the inner table for an electrical burn after surgical excision of the outer table. (Adapted from Clarkson, P., and Lawrie, R. S. The management and surgical resurfacing of serious burns. *Br. J. Surg.* 33: 311, 1946. Permission is granted by John Wiley & Sons, Ltd., on behalf of the British Journal of Surgery, Ltd.)



Fig. 13. View of the patient shown in Figure 12 after healing. (Reproduced from Clarkson, P., and Lawrie, R. S. The management and surgical resurfacing of serious burns. *Br. J. Surg.* 33: 311, 1946. Permission is granted by John Wiley & Sons, Ltd., on behalf of the British Journal of Surgery, Ltd.)

Table 6. The U.S. Influence

- Colonel Edward Churchill of Massachusetts General Hospital
- Major Samuel Balkin (advice on the treatment of facial injuries; later president of the American Society of Maxillofacial Surgeons, 1958)
- Major Carl Clark (providing Vultex facial prosthetics)
- Captain Hubin (advice on glue fixation of skin grafts)

bridement and the management of massive facial injuries would be different.

After the war, Clarkson became involved in the fresh horizons of hand surgery, establishing the Hand Club in London in 1952, which in 1968 became the British Society for Surgery of the Hand. He set up the first section of plastic surgery in the Royal Society of Medicine, of which he became first president in 1967 shortly before his death. His other achievements include the coining of the name Poland's syndrome,¹¹ attributing the syndrome to Alfred Poland,¹² who dissected an executed convict in 1841 at Guy's Hospital and noted a hand and chest deformity.

CONCLUSIONS

Described by one referee, Sir Heneage Ogilvie, as possessing "a touch of genius," Clarkson definitely possessed the able mind needed for his

Surgical Unit.¹⁰ Rex Lawrie pursued a long career in general surgery and Clarkson died young. Had he lived into retirement, we suspect that our modern account of the evolution of early burns de-

progress. His discipline in recording data served to provide the essential feedback that allowed him to question prevailing surgical culture, and his results have stood the test of time, which would imply that this was a good thing; evidence for practice in the early half of the twentieth century was often conspicuously absent.¹³ Perhaps it is therefore notable that a recent editorial in this *Journal*¹⁴ discusses the relative lack of the use of good evidence in the modern surgical literature. Are we really doing much better today? The experience of No. 4 Maxillofacial Surgical Unit illustrates the great drag that the orthodox culture of surgery has on the progress of surgery. If this lost surgical lesson tells us anything, it tells us that it is only through the determined use of evidence that surgical orthodoxy can be challenged.

On this note, we quote the late Victorian surgeon, Sir William Arbuthnot Lane, First Baronet (1856 to 1943),¹⁵ who is arguably a grandfather of British plastic surgery, being the man responsible for setting up Harold Gillies as the first reconstructive plastic surgeon in Aldershot, England, in World War I, and whose granddaughter Clarkson married in 1937: “if everyone believes a thing it is probably untrue!”

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