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“Gearing to a time table”; the evolution of earlier surgical eschar excision in massive burns by British burns surgeons at the battles of Cassino, 1944: An example of real-time audit

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ABSTRACT

The effectiveness of burns care delivery is difficult to measure within a realistic workload and resource framework. In addition, workers must develop new tools for this purpose.

We describe a historical example from World War II describing the evolution of burns excision in the context of thorough outcome assessment, during the allied advance from North Africa up the Italian peninsular, including the battles of Cassino 1942–1945. Patrick Clarkson and Rex Lawrie working as plastic surgeons in a small forward Maxillofacial Unit were able to fully assess the management and outcome of 800 burnt servicemen. 192 burns were full thickness and required grafting. Prospective data revealed that those burns which were surgically excised and grafted between 12 and 18 days recovered more quickly than those managed by conservative dressings until the eschar had sloughed off followed by grafting. Burns managed by excision and grafting in less than 5 weeks following burning ($n = 86$) healed 8.6 days faster than those grafted later ($n = 106$). This difference was increased for massive burns of over 1000 cm², with those grafted in less than 5 weeks ($n = 17$) healing 13 days faster than the delayed group ($n = 27$).

Their transparent and simple method of prospective audit is described.

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1. Introduction

Now more than ever, burns care development will hinge on its ability to perform effective outcome analysis. This pressing need formed much of the focus for 2007s annual meeting of the British Burns Association. The creation of universal outcome standards has to date been largely hindered by both a weakness in the mechanisms of prospective data gathering and the huge complexity and variability of burns care delivery; not to mention the many tools required to assess the results.

Based on the original archive material of no. 4 Maxillofacial Unit (MFSU) 1942–1945 [1,2] with additional patient data [3], this paper reports a historical example of one such successful system, in which the burns care team was able to see the

outcome of their management strategies transparently by using basic prospective audit, achieved despite the overwhelming pressures of the battles of Cassino, Italy, 1944. A general description of the Units activities including both management of burns and maxillofacial injuries has been accepted for publication [4], the present paper examines their attention to prospective audit.

2. 1940s contemporary surgical practice

By 1941, Britain had gained a great deal of experience in the management of large Burns following the Battle of Britain. In a well written account, the New Zealander Rainsford Mowlem

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[5], then one of the “Big Four” British plastic surgeons of the interwar period [6], summarised contemporary burns management which followed the application of tannic acid:

“If there is no underlying epithelium to regenerate and desquamate, then only the knife or sepsis will remove the tan. If the knife, one is confronted with almost the same raw area at the end of, say, four to six weeks as was present in the beginning.

If sepsis intervenes, fibrosis is increased. One might take one’s courage in both hands and excise and graft the burn in the first instance, and I am sure that if this is feasible it should be done. It can be done with electrical burns, but the difficulty with heat burns is our inability to decide upon the extent and the depth of the burn. If excision is impossible, then it must be made possible at the earliest moment”.

The “earliest moment” that Mowlem goes on to describe was the result of saline bathing and topical sulphonamide powder, until the eschars are sloughed and the wound is ready for grafting [5].

3. Historical example

No. 4 MFSU was under the command of Patrick Clarkson, a 33-year-old plastic and maxillofacial surgeon recently trained at Rooksdown House under Harold Gillies. Clarkson went on after war to work as consultant Plastic Surgeon to Queen Mary Hospital, Roehampton. He also ran the Guy’s Hospital Paediatric Burns Unit, attached to the accident department until the mid-1960s. Clarkson died young and the lead author,

who is his grandson, has never met him. We have been fortunate to receive the complete photographic records of no. 4 Maxillofacial Surgical Unit, given by Clarkson’s last registrar, Patrick Whitfield. The third author, Lawrie, served with Clarkson in no. 4 MFSU, as his wartime trainee. Lawrie has been able to produce the original audit material and war reports to the Royal Army Medical Corps (RAMC), upon which the paper is written. After the war, Lawrie moved into general surgery, working at Guy’s Hospital, London.

Having read these reports we have been struck by the fastidiousness of their data collection and adherence to evidence-based practice. It is said the Second World War was a “total war”, if this is so, then their work represents a “total war on burns”

The experience of the unit commenced in Algiers, North Africa, on the 12th November 1942, just at the end of the great tank battles of El Alamein which had raged since August that summer. Following victory in Africa, the unit moved with the fifth and the eighth armies to Italy after Mussolini’s surrender where they were met with fierce German resistance in the mountains north of Naples, around Cassino. The unit was principally charged with the management of maxillofacial casualties; however, soon large burns were also being referred from the casualty clearing stations. By May 1945, the unit had treated 5000 casualties, 3000 of which were maxillofacial and 1000 were burns.

During the initial period in North Africa, burns management was heavily influenced by the prevailing conservative and expectant practices described above. This was partly exacerbated by the long lines of retreat from the desert campaigns. Clarkson was charged with getting his casualties back into active service as soon as possible, evacuation was a luxury that the Allies were reluctant to afford in the



Fig. 1 – No. 4 Maxillofacial Surgical Unit en route to the Rome Surgical Conference 1946. (Headly Atkins is visiting the unit to support the presentation.)

Mediterranean theatre. It soon became clear that the conservative approach to burns management was failing to achieve this end.

Clarkson's leadership the unit prospectively collected detailed admission, management and outcome data on all their patients (Figs. 2 and 3) on one form. Clarkson writes to the RAMC in detail concerning the reasoning behind this method and the burden it added to the unit:

4. Data collection

The unit was small; Fig. 1 shows many of them on their way to the Rome Surgical Conference after victory in 1946. Under

“Army special surgical units have concentrated to them clinical material in many respects unique in type and amount. This imposes on these units the duty of periodic

BURNS PRO-FORMA. (NO. 4 M.F.S. TEAM)

NO.	Age	Cat.	PARTS AFFECTED		
Rank, Name:			% OF BODY AREA		
Unit			B. C.	ACCDT	AGENT
Days in Hospital	Days MFST		COMPLICATIONS		
Disposal			OTHER INJURIES		
<u>History and Mode of Injury.</u>		Date	Time	Place	
Agent and Amount					
Duration					
Apparel					
Other Victims					
<u>Initial Symptoms.</u>					
Pain					
Thirst					
Eyes					
Ears					
<u>Other Injuries.</u>					
Blas					
Penetrating Wounds					
<u>First Aid and Place.</u>					
Morphia					
Treatment					
Effect					
<u>Early General Treatment.</u>					
I.V. Infusions					
Oxygen					
Sulphonamide					
<u>Early Findings</u>		Date	Time		
P.	T.	R.	BP.	Hb.	
Early Assessment					
<u>Initial Full Treatment.</u>		Date	Place	Theatre	Anties:
Scap.	CTAB	SALINE	TAN	DYE	P. O. P.
Procedure					
G.C. on Admission MFST		Date	Gen. Treatment MFST		
P.	T.	R.	BP	Hb	WBC
General			CULT	Sulph.	VIT C
				Blood	FLE
<u>Local Treatment Dates.</u>					
Ward Dressings					
Soaks					
Flavine					
S.V.G.					
<u>Cultures</u>					
C.T.A.B.					
<u>Theatre: ANAES</u>					
Saline					
Flavine					
S.V.G.					
C.T.A.B.					
Penicillin					
<u>Grafts: Date.</u>					
Surface Area					
Appearance					
Fun & Culture					
Type of Graft					
(T, D, W, R, or P.S.)					
<u>Results.</u>					
% take (days)					
Final Healing.					
<u>Donor Site</u>					
<u>Progress Summary.</u>					

Fig. 2 - Burns data collection sheet 1.

These forms included positive and negative findings on the burn or facial injury in attempt to optimize management. Patients' notes on transfer from other units were consolidated onto these forms by a clerical officer. The burn data forms (Figs. 2 and 3) recorded the presenting burn in great detail including the causation, duration and clothing. There are basic body surface charts to record the burn distribution. Initial symptoms were gathered and a note made of any other injuries. The treatment was separated into first aid at the scene including analgesia. In addition early general treatment was recorded including intravenous fluids, oxygen and sulphonamide antibiotic use. The vital signs on admission were gathered including the haemoglobin. The time and type initial wound treatment was included which consisted of scrubbing and occasional tanning of the eschar.

Similar facts were gathered for general in-patient treatment, which also included bacterial cultures, the types of



Fig. 4 – Postage stamp grafts early result.



Fig. 5 – Postage stamp grafts intermediate result.

dressings used, whether penicillin was used, and the exact time and date of excision and grafting. This included the surgical methods of skin grafting. Outcome data appears to be restricted to the healing time, percentage initial skin graft take, the donor site healing time, the appearance of the grafted skin and the presence of infection with culture results. Longer term more functional outcome included finger movements, detailing the ranges of movement over several dates. The final outcome assessment was summarised by the overall appearance of the scars and a general statement on function with longer term symptoms. Crucially, this was the only sheet of paper for the entire patients care; the information was thus centralised and easily accessible with 100% follow-up.

Later in the war, Howard Florey visited the unit and presented them with vials of penicillin powder, the use and the results of which were also carefully recorded.

5. Evolution of standardised evidence-based burns debridement

In North Africa Clarkson and Lawrie received several mass casualty admissions of acute burns from naval catastrophes off the North African coast. To speed up their return to duty, they began to assist in the separation of the sloughs by surgical intervention. Immediately it became apparent that these were healing faster than those managed traditionally, and the unit had collected the data to support this subjective assumption.



Fig. 6 – Healed postage stamp grafts.

Table 1 – The effect of timing of debridement and grafting upon time to healing.

	Size of area (cm ²)				
	0–99	100–299	300–499	500–999	1000 and over
First graft within 5 weeks	10 (10 cases)	15 (32 cases)	23 (14 cases)	22 (13 cases)	21 (17 cases)
First graft after 5 weeks	19 (23 cases)	21 (36 cases)	38 (12 cases)	22 (8 cases)	34 (27 cases)
All cases grafted	18 (33 cases)	17 (68 cases)	29 (26 cases)	22 (21 cases)	29 (44 cases)

Table displays average healing times, in days from first graft.

As the Allies advanced up the Italian peninsular, no. 4 was re-stationed in Naples. Here they were 60 miles from the battles of Cassino between 12th January and 19th May 1944. Clarkson believed implicitly in scheduling and standardising his treatment regimens, as he put it, the patients were “geared to a timetable”. They were now in a position to implement their evidence-based policy of burns excision and earlier grafting on a larger number of patients. For the first time all full thickness burns were being geared to the timetable of excision and grafting. The eschars were excised between 12 and 18 days, followed by split skin grafting in patches 3 days later, also known as postage stamp grafts (Figs. 4–6). In this era skin was not meshed, and to expand the graft it was simply laid onto the grease paper backing of the paraffin gauze and cut into strips and then postage stamp sized squares. These postage stamp grafts were then laid with the grease paper upper most on the wound. Sano tissue glue was occasionally used to fix these grafts, however Clarkson had been advised by American colleagues to use gum acacia, which was easier to prepare and could be spread across the wound surface before application of the graft. Their aim was to achieve healing by the fifth week following the burn. We quote Clarkson’s report again:

“The grafting program is planned to produce primary cover for the burnt area within 2–3 weeks of the first grafting operation. The area is inspected four days after the first grafting operation. The question is then raised; will the remaining raw area heal in 10–14 days? If the answer is no a further grafting operation is done forthwith. The program for the most severe cases (4–5000 sq. cm of full thickness loss) is slower. Primary healing for these cases is planned for 6 weeks from the time of burning; the lesser areas should be healed within a month” [2].

6. Final analysis

When they came to analyse their figures they found that in a cohort of 800 burns treated, 192 were of full thickness and required grafting. Those that had been grafted in under 5 weeks from burning healed more quickly than those grafted later (Table 1). The data also impressed Clarkson and Lawrie by showing a loss of linear relationship between the size of the burn and the time taken to heal; the healing time peaked

Table 2 – Causes of the nine deaths out of 800 burnt servicemen.

Cause of Burn	Body area (%)	Chief depth	Treatment	Day admitted post-burn	Day died post-burn	Cause death
Tank casualty	40	Full thickness loss: 2000 cm ²	Split skin patch grafts	9	42	Friedlander pneumonia of blast lung
Tank casualty	40	Full thickness loss: 2000 cm ²	Split skin patch grafts	27	40	Prolonged anaesthesia under 2.5 G pentothal. Half raw area healed
Air crash	5–10	Epidermal; infection full thickness loss	Tanninised. Fifth day gross infection. Late penicillin	38	49	Staph aureus pyaemia
Phosphorous	40	Full thickness and dermal loss	Tanninised. Sulphathiazole	2	8	Agonal Staph aureus in blood ?early acute liver atrophy.
Cordite	40	Epidermal	Vaseline gauze, penicillin	6	21	Prostatic and pumonary abscesses. Burns dry and healed
Cordite	10-15	Epidermal	Vaseline gauze	5	11	Thyoid and pulmonary abscesses. Burns dry and healed
Tank casualty	35	2–3000 cm ² full thickness loss	Vaseline gauze	8	8	Died a few hours after admission. Jaundiced ++ Hb.10%
Tank casualty	35	2–3000 cm ² full thickness loss	Vaseline gauze	8	8	Died a few hours after admission.
Cordite	40	Epidermal and dermal	Vaseline gauze	1	8	Adrenal haemorrhage

at 23 days post-grafting for those grafted in less than 5 weeks (Table 1). It no longer took twice as long to heal a burn twice the size. This observation was in the face of a surgical culture that had simply dressed large burns until they sloughed off, or worse, embalmed the eschar with tannic acid, condemning the patients to months of burns dressings and malnutrition; vastly in excess of 23 days. Clarkson stated to the RAMC in his general report at the end of the war in Europe [2]:

“It is the surgeon’s duty to remove the sloughs, graft early and terminate the disease”.

The unit managed a wide range of major burns up to 72% full thickness. Clarkson reported the successful treatment of a group of 24 full thickness burns between 50% and 72% in Italy, all of whom survived. The Unit’s burns mortality out of a series of 800 cases analysed consisted of nine patients (1.1%) (Table 2) and of these, five were major burns of over 40%. This astonishing survival rate should be seen in the context of the extremely advanced medical care that was available to the Allies at this time in the Mediterranean theatre of war. Development of anaesthetics was advancing rapidly and had become recognisably modern with the use of intravenous thiopentone. In addition, the unit worked in a multidisciplinary team known as “the trinity” composed of maxillofacial, neuro-surgical and ophthalmic surgeons. This “trinity” centred on the common need for a specialised anaesthetist highly skilled in the management of head and neck cases. In addition to these services, the unit had access to a well-organised blood transfusion service. Finally, they were treating essentially well fed, fit, fighting young men; a very different population from a domestic burns unit.

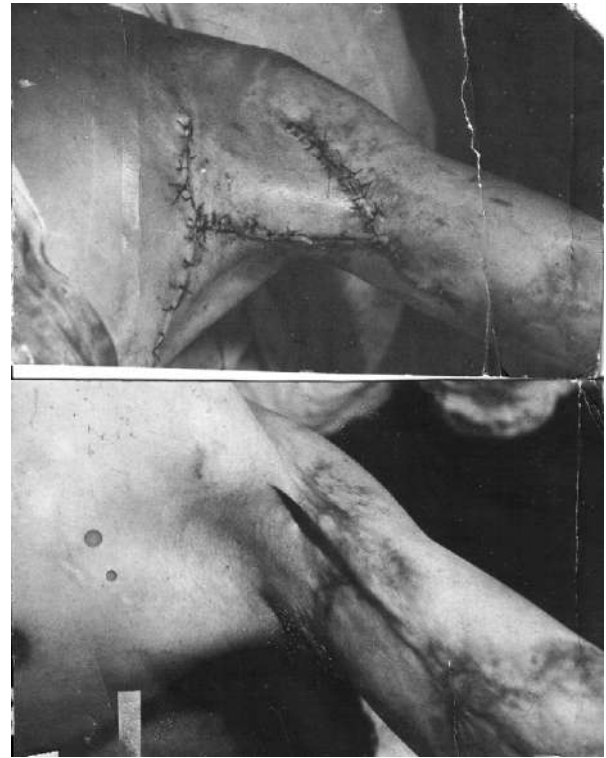


Fig. 7 – Axillary contracture release.

7. Rehabilitation

The unit kept most of their patients until they were fit for return to duty. During their convalescence they required longer term scar management and contracture release in many cases. This including anterior axillary fold and neck contractures (Figs. 7 and 8). In difficult areas such as the



Fig. 8 – Neck contracture release.

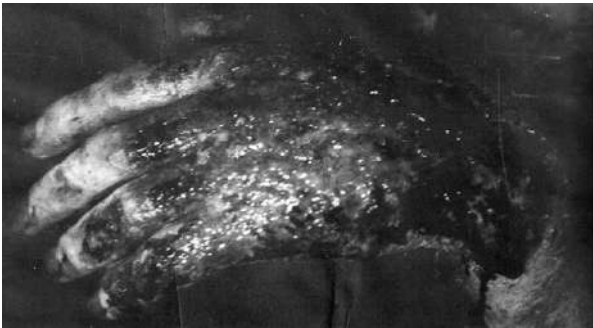


Fig. 9 – Hand burn.



Fig. 10 – Full thickness skin graft in-lays over the metacarpal phalangeal joints to enable mobilization.



Fig. 11 – Functional outcome post-full thickness hand burns.

flexion creases, hands and face Clarkson preferred to use sheet graft in place of postage stamp grafts. For the hands they went onto release the metacarpal phalangeal joint skin with full thickness skin graft inlays and early physiotherapy 1 week post-operatively (Figs. 9–11). Difficult eyelid burns were managed by tarsorrhaphy and thirsch grafts (Fig. 12).

8. Impact

The archive has a photograph of Sir Archibald McIndoe in the summer of 1944, after the battles of Cassino (Fig. 13). He was visiting the unit while convalescing in what was now Allied occupied southern Italy to recover from infective jaundice that he had presumably contracted from the water in his Unit at East Grinstead, England. Clarkson and Lawrie would have been able to demonstrate their results to their visiting senior and much celebrated colleague. By now they had to data to demonstrate the great benefit of massive burns excision, which they published in the *British Journal of Surgery*, 1946 [7]. The same cohort of patients were analysed for the effect of topical penicillin, which was shown to increase the rate of healing (Table 3) and in particular cut down the rampant spread of streptococcal graft infection. This too was published in their 1946 article, similar finding was published by Leonard Colebrook the year before in 1945 [8].

9. After the war

At the 1950 American Symposium on Burns [9] there were several protagonists for the excision of eschars. Most notable



Fig. 12 – Facial and eye lid burns requiring tarsorrhaphy and sheet grafts.

of these was Dr. Harvey Allen who reported a mortality rate of 2.78% for the method of tightly dressing the burn for 10 days followed by surgical excision and grafting as soon as possible over the following week. Clarkson attended this meeting and is recorded [10] as congratulating him on his low mortality rate, which he recognised was due to his “energetic plan of management, by which he excises the sloughs and provides a free graft cover ... within the first 10–20 days”. Harvey’s work

had validated the timing of excision published by Clarkson and Lawrie in 1946 [8].

And yet, it is reported that British burns surgery continued to follow conservative principles of burns management long after the war [10]. On review of some of the major publications of the 1950s and 1960s, it is clear that the message regarding burns excision was taken up albeit cautiously and for smaller burns [11–13]. And yet the benefits of large burn excision



Fig. 13 – McIndoe’s visit to the unit in 1944.

Table 3 – The effect of penicillin on graft healing time.

	Size of area (cm ²)				
	0–99	100–299	300–499	500–999	1000 and over
With penicillin	16 (16 cases)	15 (39 cases)	25 (13 cases)	16 (12 cases)	30 (30 cases)
Without Penicillin	21 (17 cases)	20 (29 cases)	35 (13 cases)	29 (9 cases)	27 (14 cases)

Table displays average healing times, in days from first graft.

appear to have been shied away from. Clarkson and Lawrie had firmly established a role for the surgical excision of large burns by 1946, but this work does not appear to have been widely continued in civilian practice until the later 1950s and 1960s. In Birmingham, Douglas Jackson was certainly interested in developing this idea in his Huntarian lecture of 1953 [14], enthusiastically embracing a role for the early excision and grafting of burns. However, in his article of 1960 [15] Jackson concluded that the results did not clearly demonstrate reduced infection, decreased healing time or decreased mortality rates. By now the debate was about how early the burn could be excised? Clarkson and Lawrie had laid the foundations upon which this question could be asked and their key stone was the idea that the burn should be cut off and that the timing of this event was vital to improved outcomes.

10. Conclusion

If Clarkson and Lawrie were able to achieve a high level of prospective data even during the height of battle, then the methods they used must be acknowledged to play some part in their success. One important factor in their favour was the availability of a dedicated clinical clerk to summarise the notes onto data sheets. This is a resource scarcely available in a modern health service. In addition, the authors believe that central to their success was Clarkson's use of the basic admission and inpatients notes sheet (Figs. 2 and 3). The maxillofacial units used a simple folding sheet to summaries the entire patients care pathway. Clarkson adapted this to contain more information specific to the burn, as he put it:

“Questionnaire forms are used for taking histories. They are a quick way for taking histories, noting the same points on every case in the same order, so that it is easy to look for a fact in the case history”.

In this way the conduct of their prospective audit was almost accidental, not an additional form or extra burden to the clinician. Lawrie informs us that he and Clarkson would be able to go through a large pile of such notes in an evening, consolidating them easily. The question is raised; “how can we emulate this simplicity in a complex and bureaucratic modern health service?”

Clarkson noted in one report to the RAMC [1] and in his subsequent 1946 [8], that hypertrophic scars were particularly associated with the delayed healing of partial thickness dermal burns. He will have seen this from his prospective audit outcome results (Fig. 3). Sadly we do not have a copy of his data for those burns that were not grafted and he did not publish specific figures to prove his point. Despite this, his may

be the first such observation in the literature on the relationship of time to healing and the subsequent development of scar hypertrophy, a problem that still challenges modern burns practice. He concluded prophetically:

“There is probably a role for the primary excision of ... dermal burns ... with the immediate application of free grafts”. [1,7]

Arguably, this highlights the one great weakness of their study; they lacked detail in their functional outcome analysis. Although they did try to assess scarring (Fig. 3) they failed to conclusively prove a link with healing time. As a result, they may have missed a precocious chance to introduce the modern practice of early tangential excision of dermal burns. It took the world a further 25 years until this practice was introduced by Jansecovick [16].

Although an impressive leap forward in burns survival [17], the results of early tangential excision have only partly addressed the quality of scarring. What could we be missing today? With little structured outcome analysis in modern burns surgery are we also overlooking vital and in retrospect obvious deductions? Perhaps with a more aggressive pursuit of our in-patient data and our patients' functional outcomes we might advance the discipline a further 25 years overnight!

Conflict of interest

None of the authors have any financial conflict of interest with any product or treatment promoted by this article.

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