MILITARY SURGERY IN GEOGRAPHICAL PERSPECTIVE *

A Libyan Exercise in Surgical Strategy and Tactics

By IAN AIRD, Ch.M., F.R.C.S.Ed.
Late Lieutenant-Colonel, R.A.M.C.

From the Department of Surgery, University of Edinburgh

" . . . proprio condidit horreo, quicquid de Libycis verritur areis."—Horace.
" A precedent embalms a principle."—Lord Beaconsfield.

The co-belligerency of Italy sanctions a quotation from one of her ancient poets. Like the Roman to whom Horace refers in his first ode, we have garnered in our granary everything which has been swept up from the Libyan threshing-floor. Libya is swept clean, and we hope that the need for a surgery of the North African desert has passed. The technique of that surgery was peculiar to the desert, and to a specific kind of desert. It was learned, it has served its purpose, and now perhaps it were best forgotten; but the present war is a global war, and we shall require other varieties of military surgery—a resurrection of Flanders surgery perhaps, Balkan surgery, jungle surgery, coral island surgery, Arctic and Mongolian surgery. Although the technique of desert surgery is of the past, the technique of planning a regional military surgery is of the present and of the future. The surgical needs of a campaign may be deduced from the recorded geography of the terrain over which it is to be fought, and from the contemporary trend of battle tactics. I propose in this paper to examine the manner in which general surgical principles were modified to suit a particular and peculiar locality, and a singular variety of war.

Geographical Considerations

(*a*) **The Dimensions of Libya.**—The most arresting physical feature of the North African desert is its vast magnitude. It occupies 3½ million square miles and measures 3200 miles in its broadest diameter. That portion with which we are directly concerned—the Libyan desert—includes half a million square miles and is adequate in size to contain India.

Its vastness, too, is the desert's salient military attribute. Until 1931 it was regarded as an impassable barrier for an army, and it afforded to Egypt the apparent security of a western wall. In that year, however, a group of enthusiastic British officers from Cairo, penetrating westwards to Siwa, the Jupiter Ammon of the ancients, proved that the desert was easily negotiable by motor transport, and

* Honyman Gillespie Lecture delivered in the Royal Infirmary, Edinburgh, on 24th February 1944.

dispelled complacent confidence in the invulnerability of the Egyptian frontier. From that date the desert provided a perplexing military problem, and a parallel surgical problem of commensurate intricacy.

It was obvious that base hospital requirements could not be readily satisfied west of the delta, and a surgery must therefore be elaborated to prepare wounded men to undertake, soon after operation, a long, uncomfortable journey over a waterless territory destitute of the simplest natural amenity. Let us assess in geographical terms the measure of the desert's discomfort.

(*b*) **Physiography.**—In general, Libya boasts two varieties of soil, both largely desert. The hard-surfaced northern part is limestone of

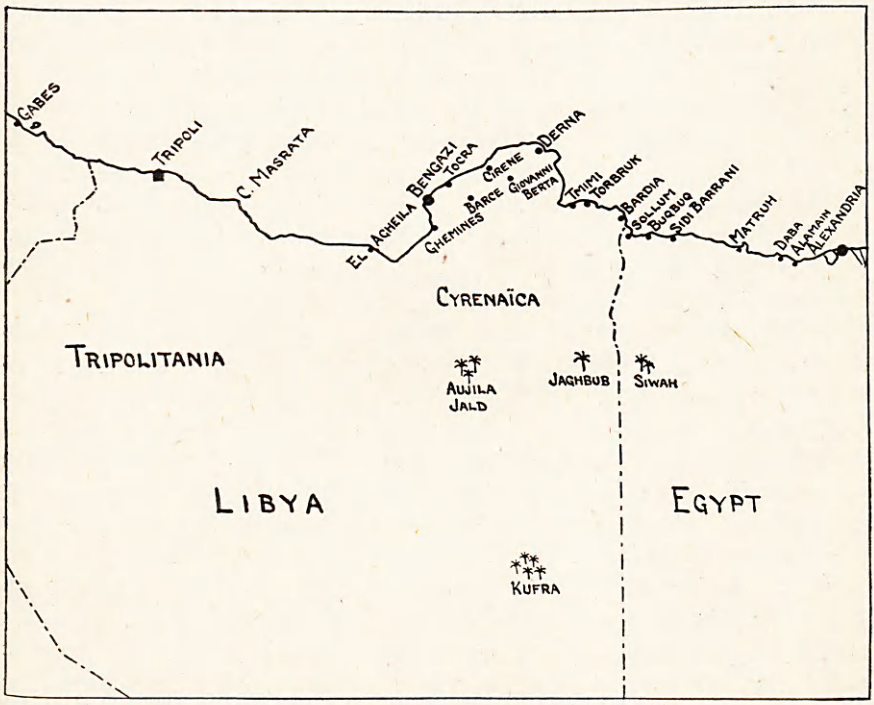


FIG. 1.—Map of Libya.

marine origin, and is composed of disc-shaped stones formed in Eocene times by the nummulite, the largest of the protozoa. From this type of limestone the pyramids were built. Here in the north there is a flat surface, grey or reddish-brown in colour, with loose stones, occasional scrub, and solid rock at a depth of a foot or two. Such a surface, though intersected in places by wadis and deep ravines, and softened occasionally in sand-dunes, offered an admirable battle-ground for highly mobile armies.

The northern hard desert is varied by two mountain ranges. The easterly range, the Jebel Akabah or Marmarican Highlands, is the barren, folded edge of the desert plateau, falling steeply seven hundred feet to the sea. The westerly range, Jebel Akhdar, in the peninsula

where Cyrene stands, rises to 1800 feet. It is of red earth, cultivated and forested on its northern slope, and on its southern affording grazing to several millions of sheep before pasture merges into desert some eighty miles from the sea.

In the interior of Libya is the Sea of Sand, vast waves of dunes still largely uncharted even by air. Here during the European ice-age flourished a tropical vegetation, which lost its moisture and its life when the ice-blanket rolled back northwards from Europe, and the North African winds changed direction and dried. The North African desert is the scorched earth of the retreat of the ice.

Perhaps the most fascinating geographical feature of the western desert is its chain of oases, Aguila-Jalo-Jaghbub-Siwa, a relic of the maritime inlet which formerly extended from the Gulf of Sidra almost to the Nile, and a rich collecting ground for marine fossils.

(*c*) **Climate.**—On a summer day the shade temperature at noon frequently reaches 120° F., and in winter a temperature of below 40° F. is not uncommon. A day temperature of over 110° F. may be followed by a fall to 38° F. at night. The humidity seldom rises higher than 5 per cent., except during the short midwinter wet season of the coastal slopes of the Jebel Akhdar. In the desert proper, rainfall is limited to an occasional cloudburst.

(*d*) **Water Supply.**—For a few hours after the rare cloudbursts wadis and ravines are flooded like torrents but dry rapidly again as the water sinks into the thirsty soil. The western desert, like all deserts, is not entirely dry.

Quite widely scattered are stone-built wells or Birs, mostly of Roman masonry, but their water may be rendered unpalatable by a retreating enemy, and it is axiomatic that a desert army must rely only on water carried from sparse, controlled water-points.

(*e*) **Soil Bacteriology.**—The soil of the stony desert, to which virtually all fighting was confined, is not sterile. A soil which supports an occasional tuft of thorn supports a bacterial flora. Pathogenic anaerobes, however, are scanty except in the cultivated sectors of the coast and in the soiled linen of warriors and nomads.

The prevalence of bacterial infection in a desert environment has long been known to soldiers and travellers. In nomadic circumstances the most trivial scratch or insect bite will readily grow to become a chronic or a spreading ulcer—the veldt or desert sore. We did not know, we still do not know, what conspiracy of climatic circumstances, dietary deficiencies, water shortage, specific infection, and insect vectors produces the desert sore, but we knew what a potent cause it could be of wastage of man-power, and we knew that the bacteriology of the established sore was rich and diverse. We suspected that desert wounds would show a similarly varied infection.

(*f*) **Dust Storms and Sand Storms.** — Air-borne infection is thicker and more to be feared in subtropical desert than in moister and more temperate regions. The desert winds, heavy with dust and

sand, penetrate everywhere, and wooden walls, canvas, blankets, dressings, and plaster casts are an incomplete protection against them. Behind every moving vehicle a cloud of dust whirls upwards to force an entrance through the slits in canvas or the cracks of doors. During the khamseen or African sirocco, set operations must be postponed for days until the wind falls or changes, for an instrument table even in a concrete operating theatre with doors and windows closed may acquire a covering of an eighth of an inch of sand in less than an hour. There can obviously be no " closed treatment of wounds " in the desert.

(*g*) **Population.**—Libya supports a population of a few hundred thousands of Berbers and Arabs. The indigenous Berbers have peopled Mediterranean Africa since the earliest human times. They were the Numidians or nomads of the Romans, and the Moors or westerners of the Hebrews ; the word " Berber " appears on Egyptian inscriptions of the fifteenth century before Christ, and the Greeks employed it to label their conception of " Barbarian." The Berbers are still largely nomadic, with a well-developed system of village government. Brown-haired or even fair-haired, with clear complexions and brown, hazel or blue eyes, they are an attractive and highly-principled people. The Berber saints, or marabouts, male and female, are numerous and influential, and their graves are highly revered—as holy places by the Berbers and as landmarks by travellers. The bones of the martyrs are the signposts of the desert.

Both Berbers and Arabs are Mohammedan. The most important religious community is that of the Senussi, who stubbornly resisted Italian domination in their desert oases and suffered the cruellest of oppressions. The Italian colonist's pronunciation of the words " Arabi " and " Barbari," which are forcibly expectorated as terms of the strongest loathing, is a measure of the intensity of Italian hatred. The Libyans as a whole, Berbers and Arabs, have high standards of independence, endurance, justice and honour, and reacted to Italian administrative cruelty by a certain primitive wildness of revenge. Cruelty has evoked cruelty, and unarmed non-combatant Italians have sometimes paid heavily for the errors of their nation's colonial policy. Unarmed allied non-combatants could move and work and sleep with impunity among the desert races—a matter of some importance to medical units in temporary isolation.

The greater part of the European population of Libya is gathered in the villayet of Tripoli, and in the ancient pentapolis, or five-city peninsula, of Cyrenaica. Benghazi, Tocra, Barce, Cyrene, Appolonia, Giovanni Berta and Derna in the peninsula, and Tobruk and Bardia outside it, are the only inhabited localities east of Tripoli. A few other place-names—Memili, Ghemines, Tmimi—boast a building or two, but most, Gazala, Sidi Rezegh, El Gubi, Sidi Omar, Msus, and the rest, are featureless map references—" no local habitation yet a name."

(*h*) **Communications.**—A hundred miles or so of rail at Tripoli and at Benghazi, and a single coast road duplicated only in the pentapolis, offer a narrow and interrupted communication line for an army. The hard-surfaced northern part of the desert, however, to which most of the fighting was confined, is mostly navigable by motor transport. At times, if the need arises, a speed of forty or fifty miles an hour is attainable over desert tracks or even over open ground, but night driving without lights is hazardous, particularly for soft-springed ambulances with their valuable cargo. More comfortable transport facilities for the evacuation of wounded seemed to be offered by the sea, but the only adequate ports were Tripoli, Benghazi and Tobruk, with long road transport before evacuation in each case. Air evacuation—an apparent solution to evacuation difficulties—is separately considered.

Military Considerations

The open, hard-surfaced, unpopulated desert seemed an ideal terrain for the war of movement which was promised already by the Battle of France. Desert surgery had therefore to be prepared to deal with casualties scattered over a wide area, with frequent changes in the tactical situation, and with a narrow and lengthy line of evacuation.

Historical Background

In the planning of a surgery for a campaign in the western desert, former records were of little assistance. There had been three campaigns fought by Europeans in Libya :—

(1) The first of these, a remarkable American expedition of 500 irregulars under William Eaton, which marched by the coast route from Alexandria in 1805 against the pirate Pasha of Tripoli, penetrated as far as Derna, but left no surgical records.

(2) In the campaign fought during the first world war by our army in Egypt against the Senussi, from December 1915 to March of the following year, casualties were embarked direct from the field ambulance to the hospital ship " Raschid," first from Matruh, later from Barrani, and finally from Sollum. Only for twelve days did a detachment of a stationary hospital function as a C.C.S. at Sollum, and the total number of wounded in the campaign was small.

(3) Any surgical records which exist of the Italian campaign against the Senussi in 1931, culminating in the subjugation of Kufra, have not been available to me.

More helpful to the early desert surgeons was the record of field surgery in the Palestine campaign of 1917. A mobile operating theatre designed in 1914 by Mr (then Colonel) Henry Wade for the Scottish Horse Mounted Division was in service at Suvla during the Gallipoli campaign, at Kantara in the defence of the canal, and at Beersheba during the invasion of Palestine. It permitted the performance of

forward surgery in cavalry engagements, and proved efficient on the wire roads of Sinai.

Surgical Strategy

The vaster distances of the western desert, and the promise of a more rapidly moving war, demanded mobile, self-contained units, capable of opening and closing rapidly, and of moving quickly, efficiently and without breakdowns over open desert. Such units had to be suitable for grouping and regrouping in a changing pattern, and for working in field ambulances or casualty clearing stations according to the fluidity of the tactical situation and the elastic variation of the evacuation line. Experience finally decided the contest for supremacy between the " theatre caravan " (Figs 3 and 4), which was comfortable in operation, relatively sandproof, and easy to open, but expensive, and lost temporarily or permanently if a chassis defect developed, and the " tented theatre " (Figs. 5 and 6), which was slower to open and less sandproof, but movable with its equipment from one truck to another in case of breakdown. Earlier desert surgeons were allowed wide latitude and were encouraged to experiment in equipment and accommodation, and a valuable lore was accumulated and pooled in harmonious comradeship.

The final provision of small, motorised, independent surgical units is a story whose telling must be postponed until peace is here. I do not propose, nor am I authorised, to discuss the methods whereby, in these units, solutions were found for problems of personnel, equipment, accommodation, transport, supplies, nursing, dieting, lighting, heating and sterilisation. It is sufficient to say that the final establishment approximated closely to the design envisaged by the early desert surgeons.

The problems to be solved in the development of a desert surgery may be tabulated, so far as their discussion is permissible, in Table I. Each problem suggests its own solution.

TABLE I

The Problems of Desert Surgery

Problem.	Solution.
1. Mobile war.	Mobile Surgical Units, experienced in desert navigation by the sun-compass and the stars, with portable cover for theatre and ward, compact sterilised dressings adequate for long periods, generous provision for vigorous resuscitation and high standards of sickroom diet and cooking.
2. Rapid changes in position over featureless desert.	
3. Absence of buildings.	
4. Long supply lines.	
5. Wounds sustained after long periods of water shortage and battle rations.	
6. Wide variations in day and night temperatures.	Heating of tented wards at night.
	Care in selection of anæsthetic apparatus.
7. Water shortage.	Rigid economy in scrubbing up and sterilising.
8. Heavy air-borne infection	Anticipation of sepsis.
9. Distant base hospitals.	Forward surgery to be merely a preparation for a lengthy evacuation journey.
10. Long, comfortless evacuation line.	Rigid immobilisation.
	? Air transport.

(The only geographical factor on the credit side appeared to be the paucity of pyogenic anaerobes.)

The Forward Management of Wounds

The Regional Argument against Excision and Suture. The two dominant considerations to be regarded in the elaboration of a standard technique of wound management were the length of evacuation line and the peculiarities of desert bacteriology.

The establishment in the western desert of a number of hospitals sufficient to undertake, at an early stage, the permanent management of wounded, was impossible in the face of the geographical situation which I have sketched. Rapid evacuation by air could not be relied upon for all casualties, and the relatively rapid sea transport which was employed in the Senussi campaign of the last war must at best be combined with land evacuation in most cases, so far apart were the ports. All wounded must therefore face a long journey of many days' land travel at an early stage in their post-operative course. Forward surgery must be a preparation for a long and trying evacuation, and the first purpose of any operation must be to ensure for the patient a safe and comfortable journey.

From a study of desert bacteriology, tetanus and gas gangrene were regarded less seriously than they were in Flanders in the last war. Immunisation and prophylaxis were expected to protect against the former, and the nature of the soil offered a fair assurance of low incidence of the latter. Early confidence was justified in the event; MacLennan records only 164 cases of true gas gangrene in the three Libyan campaigns, in spite of a generally conservative operative treatment. In many hundreds of cases of compound fracture I saw gas infection frequently enough, but true anaerobic myositis (gas gangrene) only twice. In both these cases the main vessels of the affected limb were severed by the original wound, and gas gangrene became established in a limb which was already dying.

If gas gangrene was not expected, infections of other kinds—less immediately serious to life yet no less productive of prolonged disability—seemed likely, from our knowledge of air-borne infection and of desert sores and ulcers, to be common enough. This risk of infection, ever present over a long line of communication, seemed to preclude excision and suture. I know of no circumstances and no technique which would permit a patient in the desert with a sutured wound to embark immediately upon an evacuation journey of several days' or weeks' duration. Had forward hospital facilities been available in Libya, and had it been possible to hold patients after operation for a week or two, I believe that excision and suture might have been successfully practised in selected cases—as indeed they were during rare static periods. Wound closure, if practicable, might have reduced the incidence of late infection and secondary infection.

Wide excision, even without suture, seemed to threaten special dangers. The surgeon proceeding to the Middle East was inclined, like the Crusaders before him, to burden himself with an unsuitable

European armour—the surgical panoply of the Spanish war and the air war. In the desert, the war-cry "The sword of the Lord and excision" seemed not entirely free from danger—the danger of turning small septic wounds into large septic wounds. When block excisions were performed, this theoretical danger was substantiated in fact. Large raw surfaces could not always be protected against infection, and the operation of excision sometimes caused more disablement than the injury for which it was performed. Wound excision and any form of suture having been regarded as impossible, what operative measures were available to reduce the ultimate period of disability?

Penetrating and Perforating Wounds.—Small penetrating and perforating wounds of soft parts, those produced by rifle bullets, for example, offered no great difficulty in treatment. In most a formal excision was impracticable, even had it been desired. They were treated for the most part by immobilisation and sulphonamide by mouth, and they did well, tenderness along the line of the track being the only persistent symptom. Late suppuration was unusual, except in relation to large retained foreign bodies, and early exploration was required only for the removal of a large and relatively accessible foreign body, for the closure of an injured viscus or large vessel, or for the evacuation of a tension-hæmatoma in a closed muscular compartment such as the calf.

Extensive and Lacerated Wounds.—In planning operative detail for the treatment of lacerated wounds, regard must always be had to the future, and an imaginative picture should be painted not only of the ideal which is to be aimed at, but also of the misfortunes which are to be avoided. What, in other words, are the conditions which prolong sepsis and delay healing, and how can these conditions be prevented? An attempt to answer these questions in detail is presented in Table II.

TABLE II

Wound Economy in Desert Surgery

Causes of Prolonged Sepsis.	Avoided by Steps in Wound Treatment.
Closure of skin wound.	Adequate enlargement of wound by incision.
	Avoidance of sutures unless patient can be held 7-10 days.
Extensive skin loss.	Avoidance of wide skin excision.
Apposition of fascial edges.	Wide incision of fascia across its fibres.
Anaerobic infection of muscle.	Unlikely in Libya. "Trimming" of muscle only.
Infection of bone.	Drainage from broken bone usually free.
	Removal of completely detached fragments only.
Retained foreign bodies.	Removal of metallic and textile fragments.
Vaseline gauze plugs.	Avoidance of packs and ribbon gauze.
	? "Double roll" technique.
Movement.	Immobilisation.
Gravity.	Maintain horizontal position. Dependent drainage.
Bacterial growth.	Sulphonamide insufflation.
	Sulphonamides by mouth.
	Protection against tetanus.
	? Protection against diphtheroids.

1. *The Skin.*—The skin is a fruitful source of wound infection, and care was always taken to shave and to wash thoroughly with

soap and water a wide area around any wound, and the whole surface of a wounded limb, but actual skin infection is rarely serious, and wide excision of healthy skin seemed to be unnecessary. Wide skin excision is itself a cause of delay in healing. Sepsis may be prolonged in a deep broad wound with a narrow bottleneck at the skin opening, but this seemed avoidable by incision. Excision was limited to removal by scissors of a few millimetres of the skin edge.

2. *Fascia.*—Deep sepsis and abscess formation are frequently encouraged by tight apposition of the edges of the fascial wound, particularly in the case of the fascia lata. To abolish this dangerous barrier to drainage, which seemed likely to ensure the patient's arrival at base with a deep pool of pus in the muscle layers, the deep fascia, and especially the fascia lata, was always divided widely across the line of its fibres.

3. *Muscle.*—Muscle infection was uncommon, and muscle is seldom a barrier to drainage. Only dead muscle was excised with scissors.

4. *Bone.*—While entrenched infection in broken bone-ends is an important cause of prolonged disability, I know of no technique which advocates more than the removal of completely detached and grossly contaminated fragments.

5. *Foreign Bodies.*—Retained foreign bodies are a potent cause of protracted sepsis, which in a soft tissue wound seldom occurs in their absence. The higher the proportion of foreign bodies removed early, the lower the incidence of prolonged sepsis, and the sooner removal is attempted the more likely is the foreign body to be found. Where X-rays are available removal is easier, but even without X-rays the track may usually be found by the finger, which is the best probe. When the skin wound is enlarged the fascial wound is seen and points to the general direction of the track. Ross Lowdon has stressed the importance of placing the limb in the position which it occupied at the time of wounding, so that sliding tissue layers may reassume the initial relationships which give direct continuity to the track.

6. *Vaseline Gauze.*—Packs, particularly packs of ribbon gauze, were avoided, after unfortunate early experiences. For the maintenance of a wide drainage channel in the superficial tissues, I have found some advantage in the "double roll" technique. After preparation of the wound, a flattened roll (see Fig. 2) of vaseline gauze is inserted between skin and fascial edges at each end of the wound. This stretches open the central portion of the wound, which is covered by several layers of dry gauze, laid between the rolls, and the effect of a broad excision is obtained without skin loss.

7. *Movement.*—Even slight movement of muscles will milk infected material along tissue spaces and lymphatic channels, and spreading infection from this cause seemed likely to be encouraged by desert transport during evacuation. Methods of immobilisation received so much attention in Libya that they will be separately considered.

8. *Gravity.*—A potent cause of gradually spreading infection in an infected compound fracture is high elevation of the wounded limb. In thigh injuries, flexion of the hip is sometimes dictated by the needs of fracture alignment, and the patient frequently sustains a succession of gravitational abscesses at higher and higher levels. A thigh elevated at 45° drains for preference along its proximally-directed fascial planes. For this reason a nearly horizontal position is desirable for a thigh the seat of infected compound fracture.

9. *Specific Infections.*—The insufflation of sulphanilamide powder after operation, to produce a thin frost on the raw surfaces, was always performed. Among the causes of prolonged sepsis, however, organisms

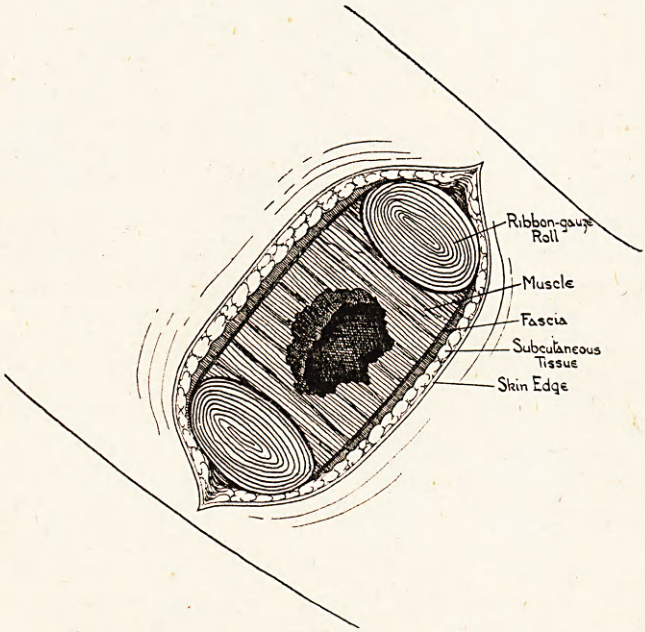


FIG. 2.—Double-roll Method of Wound Drainage.

resistant to available bacteriostatic chemicals should be included. The diphtheroids, for example, were frequently found as superficial and secondary contaminants of infected wounds, and the Klebs-Loeffler Bacillus produced a number of peripheral palsies. Diphtheritic serum is, of course, of no local antiseptic value, being strong in antitoxic, but weak in antibacterial effect. For sectors where diphtheritic wound infection is common, the preparation of an antibacterial serum might be considered; other sulphonamide-resistant (and penicillin-resistant) organisms may require a similar specialised prophylaxis or treatment.

Immobilisation.—1. *Femur.*—The long evacuation route was a searching test of immobilisation methods, and the painstaking search for rigid immobilisation is well illustrated in the elaboration of the "Tobruk Plaster," which is a suitable monument to the forward

surgery performed during the siege of Tobruk by Lieut.-Col. R. Marnham's surgical division in the fortress hospital, and which is likely to prove standard in any theatre of war, military or civilian, from which wounds of the femur must be evacuated early after operation.

The general principles of the method are well known, but individual modifications are almost as numerous as surgeons, and it is not generally understood which modifications of detail are permissible and which have proved harmful in actual practice. One method of application is illustrated in Figs. 8-14. The operation having been completed and the wound dressed, extension strapping is applied on each side of the limb from lower limit of wound to malleoli, and manual extension is maintained henceforth (Fig. 8). To facilitate splitting of plaster later, a thick rubber tube or a strip of metal is laid along the front of the limb from groin to toes. The limb is then wrapped in a thin layer of wool or other padding, particular attention being paid to the neck of the fibula, the heel, and the dorsum of the foot (Figs. 8 and 9). A posterior pad of wet plaster is prepared, and applied from buttock to metatarsal heads (Fig. 10), and a circular bandage encloses the limb over the same extent, leaving avenues of transit at the ankle for the extension tapes (Fig. 11). Care is taken to maintain the ankle in dorsiflexion and the knee at 10° short of full extension. A Thomas splint, preferably angled ten degrees at the knee, is applied before the circular bandage is completed, and the uppermost encircling turns include the upper limit of the inner limb of the Thomas splint (Fig. 9), to draw the ischial tuberosity inwards against the ring of the splint. A massive pad between the haunch and the outer edge of the ring assists in maintaining the medial situation of the tuberosity. Windlass extension is now established to the end of the splint, and three plaster slings are applied circularly around the plaster casing and both limbs of the splint, one round the upper thigh, one round the knee, and one round the leg (Fig. 12). The whole case is split as soon as it is dry, after withdrawal of the rubber tube or metal strip (Fig. 13). Padding, case and plaster slings are all divided, and the limb is slung from the suspension bar of the stretcher so that the heel is just clear of the canvas and the limb almost horizontal.

Any modification of the method should not depart from certain general principles :—

(1) The method should be employed only after operation, not as a first-aid measure.

(2) Extension must be by strapping. If skeletal traction is used the traction pin tends to ease downwards in the bone in which it lies, and draws down the plaster with it, to chafe the dorsum of the foot.

(3) The extension strapping must lie clear of the edges of the opening in the plaster case through which it passes. It must not pull on the plaster.

FIG. 3.—Caravan Type of Mobile Operating Theatre.

FIG. 4.—Interior of Caravan Operating Theatre.

FIG. 5.—" Lean-to " Operating Truck Packed.

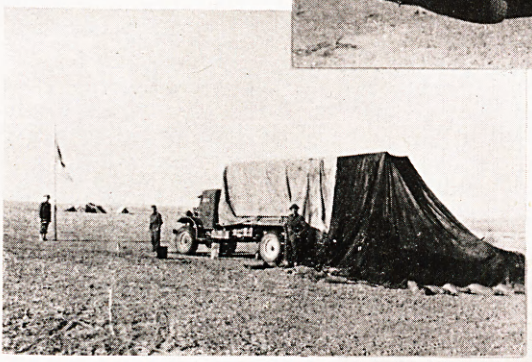
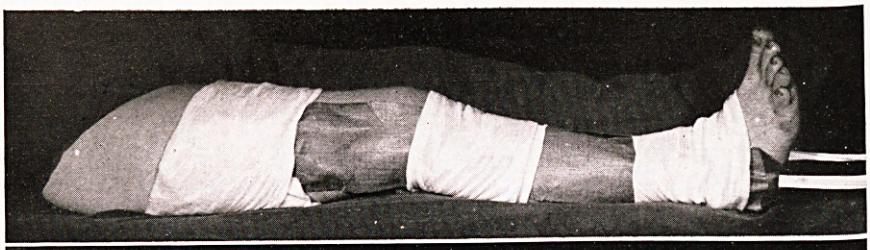


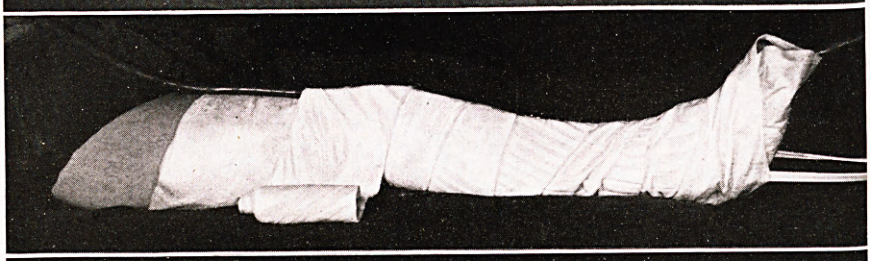
FIG. 6.—"Lean-to" Operating Truck in Process of Erection.

FIG. 7.—" A long-delayed and serious operation in a desolate scene."

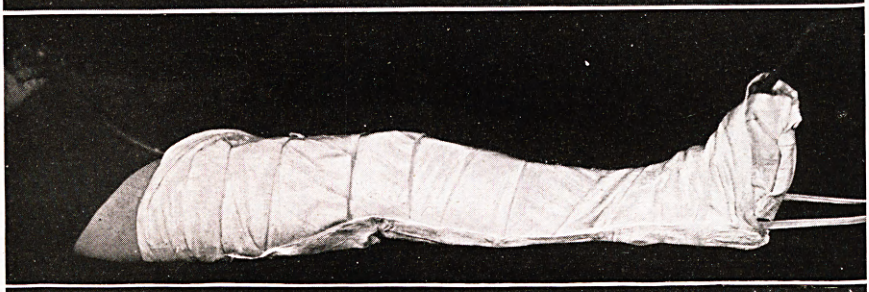
8



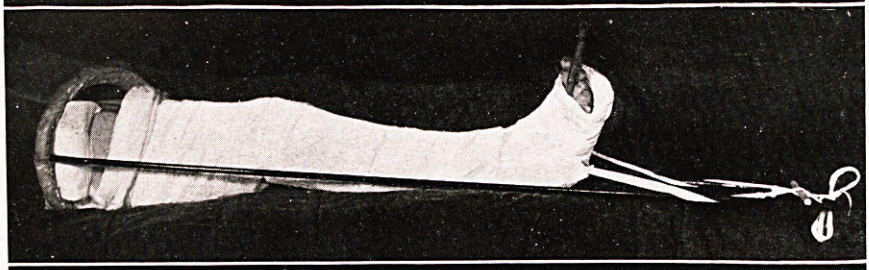
9



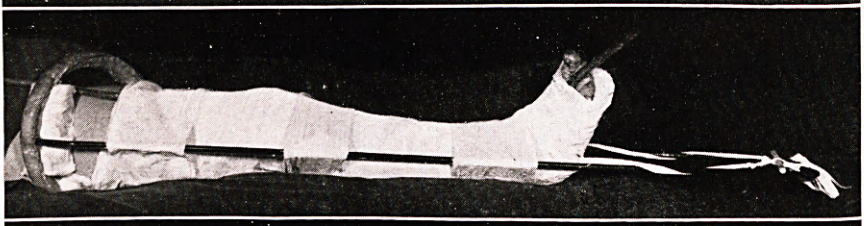
10



11



12



13

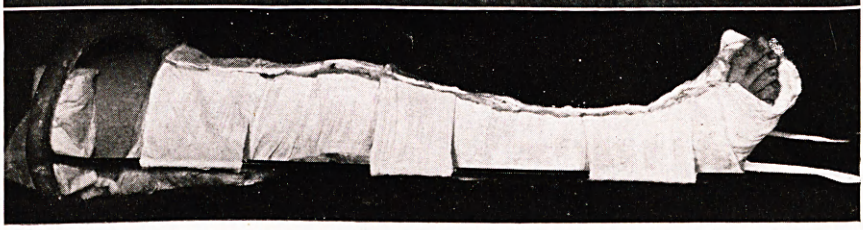
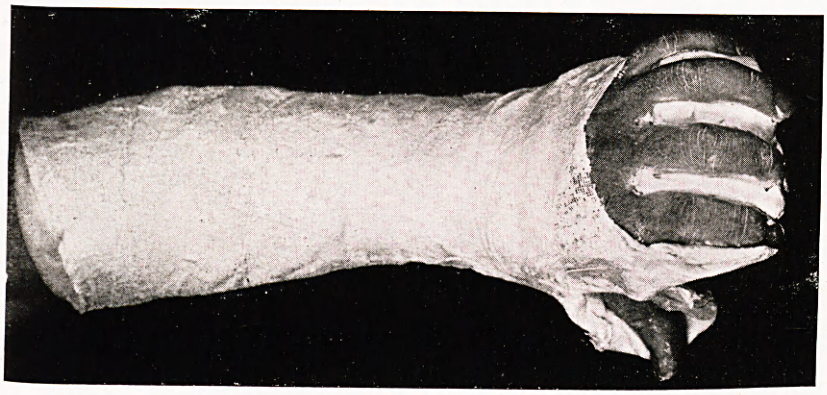


FIG. 8.—Tobruk Plaster. Extension Strapping and Wool Pads.
FIG. 9.—Tobruk Plaster. Rubber Tube and Circular Padding.
FIG. 10—Tobruk Plaster. Posterior Slab applied.
FIG. 11.—Tobruk Plaster. Thomas Splint. Windlass Extension. Circular Plaster.
FIG. 12.—Tobruk Plaster. Slings around Splint, and Plastered Extremity.
FIG. 13.—Tobruk Plaster. Padding, Circular Plaster, and Slings split along entire extent.

FIG. 14.—Tobruk Plaster. Final Circular Turns include Inner Limb of Splint. Pad between Haunch and Ring.



FIGS. 15 and 16.—Hand in " Position of Function " in Plaster Case, with wrist dorsiflexed, fingers slightly flexed at all joints and separated by ridges in volar plaster slab. For hand wounds and burns.

FIG. 17.—U-slab applied, after Padding, to Fracture of Humerus.

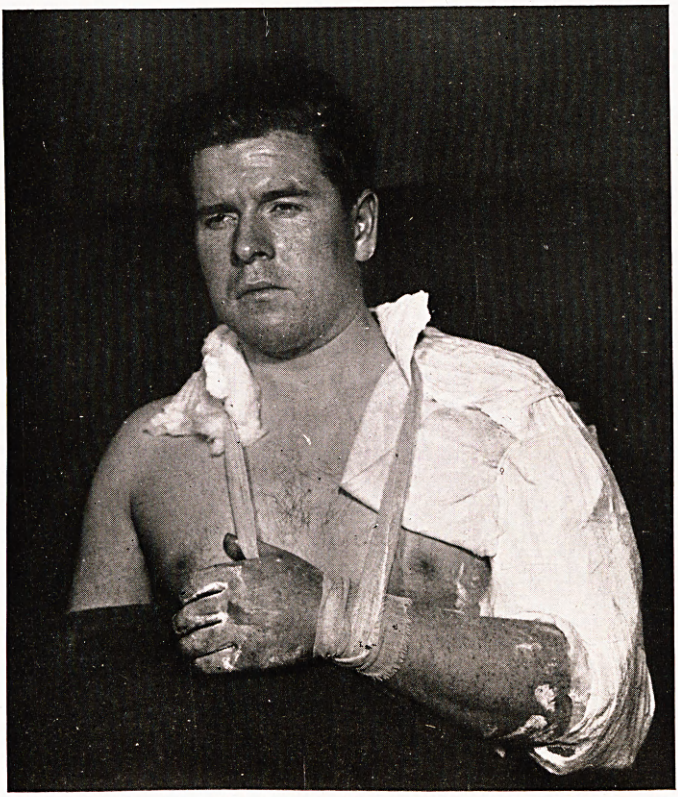


FIG. 18.—Slab fixed by Circular Plaster Bandage.

(4) At least the neck of the fibula, the heel and the dorsum of the foot must be liberally padded.

(5) No textile slings should lie between plaster and limb.

(6) The plaster should extend to the metatarsal heads. If it is carried downwards only to the ankle, and a footpiece is employed to maintain dorsiflexion of the foot, sooner or later the toes will sag downwards and the heel will chafe against the lower limit of the plaster.

(7) Padding should be split as well as plaster case. Padding impregnated with wound secretion will, when it dries, constrict the swelling limb as powerfully as does plaster.

(8) Some method of fixation of ischial tuberosity against inner side of ring must be employed—on this step particularly depends the comfort of the patient during evacuation.

2. *Humerus.*—The method of immobilisation of upper arm fractures was also dictated by evacuation requirements. Any form of abduction splint is inconvenient in a motor ambulance, and for this reason, though not all fractures of the humerus are best treated in adduction, adduction became the routine position for upper arm fractures in forward areas. After careful padding of shoulder, arm and elbow, a long U-shaped slab was applied (Fig. 17) from the root of the neck, over the point of the shoulder, down over the lateral aspect of the arm, round the point of the elbow, and up over the inner arm to the axilla. This slab was then bound to the arm by a few circular turns (Fig. 18) and its upper extremity was turned downwards as a hook, so that a narrow arm sling could be applied to lie in the hooked upper extremity, preventing up-riding of the plaster case. For still more rigid immobilisation a pad of wool may be inserted between plastered arm and chest wall and the limb bound to the chest by flannel bandages or by a complete thoraco-brachial plaster cast.

3. *Hand.*—A hand plastered in the position of function on a volar slab is also illustrated (Figs. 15 and 16). This method was useful in immobilisation of fractures of metacarpus and phalanges, wounds of the wrist joint, and burns of hand and fingers. The fingers are separated by ridges on the volar plaster slab. Movement of the fingers is easily obtained.

Burns.—The burns sustained in armoured vehicles and around cooking fires fuelled by sand and petrol unskilfully mixed, were a special problem in the desert. The moistureless atmosphere dried first-aid dressings almost immediately. My first intention was to use a saline dressing kept moist during evacuation by repeated soaking. I arranged ambulance convoys carefully, evacuating lightly-wounded commissioned and non-commissioned officers with the burned men, and charging them with short but detailed orders for soaking. Even then, patients arrived at staging-posts with dry dressings and in pain.

For burns of the extremities I found no better dressing, for application after surgical cleansing, than sulphonamide-vaseline gauze, and

a padded plaster cast. This valuable combination, first suggested, I think, by Lieut.-Col. D. L. C. Bingham, and recommended also by Lieut.-Col. N. J. Logie, has the advantage of being applicable to burnt hands, provided the position of function is maintained (Figs. 15 and 16), and care exercised to separate burnt fingers from each other.

During desert evacuation, however, even vaseline gauze sometimes develops a crusty texture which may be exceedingly uncomfortable, and the ideal early dressing for burns sustained in battle is still awaited.

Abdominal Wounds. — In planning a desert surgery, it was difficult to decide what abdominal wounds, if any, should be regarded as inoperable. The argument that only " best-risk " abdominal cases should be submitted to operation does not want support. Indeed it does sometimes seem unprofitable, in a busy advanced operating centre, to expend priceless hours and precious surgical facilities upon a list of time-consuming abdominal cases, which will include few successes, when time and surgery might be more profitably employed in hastening by early operation the return to duty of patients wounded in the limbs. Nevertheless, I believe that this argument should be disregarded. I know of no wounded man who, by reason of our preoccupation with abdominal cases, passed untreated through any of the various dressing stations to which I was attached, and who died later as a result of the postponement of his operation.

Believing that the first aim of military surgery is the saving of the maximum number of lives, I decided to operate upon all abdominal cases whose systolic pressure could be induced to rise to 100 mm. of mercury, a level which proved to be attainable in every case of penetrating wound of the abdomen. This rule seems, even in the most detached and unsentimental view, to be economical of life and conservative of man-power, particularly when it is remembered that if a patient with an abdominal wound recovers, he returns to duty substantially sooner than does a patient whose femur or tibia is broken.

I do not propose to present an account of all my cases of abdominal wounds—their total number was relatively small in comparison with the figures of others. For my particular purpose I shall consider only a small series in which operation was not possible until more than twenty-four hours after wounding. I believe this series supports my contention that to operate upon all abdominal wounds, provided there is a satisfactory response to resuscitation, is a life-saving decision. The series has a subsidiary value in demonstrating that painstaking planning provided measures for the management even of abdominal cases in the desert.

I operated upon 11 perforating wounds of the abdomen 24 hours or more after the time of wounding. The details are presented in Table III. This relatively large number of late abdominal cases was in spite of an advanced operating situation in the forward main dressing station of a division. The delay in collection of these cases was due to a combination of factors, the most important of

which were the difficulty of collecting wounded from a scattered and rapidly changing battle-line and from units deeply penetrated in the enemy line, and the hazards of night navigation over an irregular and darkened battle area.

TABLE III

Précis of Late Cases of Penetrating Abdominal Wounds

	Race.	Age.	Interval before Operation.	Injury.	Operation.	Day Evacuated.	Result.
1	English	25	24½ hrs.	Peritonitis without visceral injury. Prolapse of omentum Wound of left orbit	Laparotomy (Drainage of maxillary antrum)	...	Recovered
2	English	24	26 hrs.	Large shell fragment in loin Compound fractures hand	Removal of fragment from loin	3rd	Died 10th day. Subphrenic abscess
3	English	27	27 hrs.	Ileum (2), jejunum (1), mesentery	Perforations closed	...	Died
4	Sikh	25	28½ hrs.	Transverse colon (2), ileum (1)	Closure	3rd	Recovered
5	English	22	29½ hrs.	Mesosigmoid (1), jejunum (2)	Jejunum closed	...	Died 24 hrs.
6	Sikh	35	30 hrs.	Jejunum (1), trans. colon (2), spleen, chest (penetrating), upper arm (L.), hand (L.)	Perforations closed	2nd	Recovered
7	Sikh	28	34 hrs.	Pleura (pneumothorax), spleen	Pleural opening closed, pleura aspirated, tamponnade of spleen	3rd	Recovered
8	Sikh	20	36 hrs. +	Liver, ascending colon (1)	Suture of colon	3rd	Recovered
9	Sikh	20	39 hrs.	Ileum (4), pelvic colon (1)	Suture of ileum, exteriorisation of colon	...	Died 1 hour
10	English	23	40 hrs.	Cæcum (2)	Cobbling of cæcum	...	Died 24 hrs.
11	Welsh	23	41 hrs.	Retroperitoneal hæmatoma	Control of hæmorrhage	...	Died of subphrenic abscess 2 months

Of the 11 cases recorded here, 7 (one of which was abdomino-thoracic) presented wounds of hollow viscera. Of the remaining 4, one was an abdomino-thoracic wound with a rent of the spleen, and one a large tear in the liver which required suture. Two cases presented no visceral injuries, but in all peritonitis was established, and in the case of the colonic injuries this was thickly purulent. Of these 11 cases, 6 survived for a period of one month, though one of the 6 died after 9 weeks from a subphrenic abscess which was unsuspected before death. One of the surviving cases was a Sikh who sustained a puncture wound of the ascending colon and a large laceration of the liver; his operation was not performed until more than 36 hours after wounding, and by then a fæcal peritonitis was present. The time limit for a successful closure of the colon in the last war was 36 hours. The recovery rate in the series, small as it is, compares well with the general figures of penetrating wounds in the last war, when the mortality of all cases, including the earliest and most favourable, was not less than 60 per cent.

The relative improvement in the treatment of these late abdominal

wounds cannot be ascribed to an improvement in operative technique—I do not believe that the craftsmanship of the masters of abdominal wound surgery in the last war can ever be surpassed, and it is doubtful whether it can be equalled. Nor was recovery due to intraperitoneal sulphadiazine—no intraperitoneal sulphatherapy was employed in any case of the series. All, however, received intravenous plasma and saline in full measure, some of them many litres per day, and most had the benefit of nasal suction drainage, and to these two measures must be ascribed the relatively high survival-rate. The Sikh recoveries are particularly interesting—it has for long been believed that vegetarians recover more readily from wounds of the hollow viscera than do meat-eaters.

Tribute should be paid to the stamina and determination of the surviving patients in this series. Seldom can men have endured greater suffering. Ten of the patients in this series, after sustaining mutilating wounds and a long-delayed and serious operation, experienced, early in their post-operative course in the desolate scene illustrated in Fig. 7, enemy attack and capture, the disturbance of artillery and armour in battle around them, the anxiety of partial release, a precarious freedom for a time between the lines, and a precipitate withdrawal from a closely-pursuing and partly-investing enemy less than 70 hours after operation. Their stoicism is worthy of record.

Anæsthesia.—All my abdominal operations and most other major operations were performed under endotracheal nitrous oxide, oxygen and ether. For minor procedures pentothal was employed. Major J. B. Bamford, who anæsthetised for me and who later commanded a surgical unit, used a portable Boyle's machine during a period of over two years' almost continuous forward surgery, in which he covered many thousands of rough cross-country miles. The machine suffered no breakage, gas and oxygen supplies were always adequate, and wide extremes of temperature did not seem to affect the efficiency of the apparatus. The provision of highly skilled anæsthesia is essential for effective operative work on the recently wounded, and my patients were fortunate in this particular respect.

Sulphatherapy.—The continued oral administration of sulphonamide over a long evacuation line required the development of a special sulphonamide programme. Prophylactic needs seemed to be satisfied by the administration, to all wounded on every convoy, of five tablets night and morning.

Since all wounds were treated by trimming, immobilisation, and prophylactic sulphonamide, the contribution of sulphonamide is difficult to assess.

Too much sulphonamide was sometimes exhibited, particularly in cases of burns. Not only does an excess of sulphonamide produce a thick crust which prevents escape of wound secretion, but there is a real risk of sulphonamide poisoning, particularly when the patient is dehydrated.

During the first battle of Agheila, Lieut.-Col. R. J. Kellar (whose experience of desert surgery is unrivalled) admitted to his unit a man with two minor flesh wounds, without muscle damage, who had developed anuria after 5 gm. of sulphanilamide by mouth. There was no means of proving sulphonamide blockage of the renal tubules, but this seems the likeliest explanation of the anuria—which was preceded by slight hæmaturia, and which persisted for 72 hours. Lieut.-Col. Kellar evacuated the patient to my unit with a diagnosis of sulphonamide anuria, and secretion was re-established by the forced administration of alkaline fluids by mouth, and 3 litres of intravenous saline at the rate of 250 c.c. per hour. This single case illustrates how heavily previous dehydration weighed in the estimate of the therapeutic needs of the individual soldier.

Water Shortage

This proved less serious than was anticipated, and surgical units were always afforded high priority. Economy was nevertheless rigid. The expenditure of water upon sterilisation was reduced by the use of pre-sterilised gowns, gloves and towels, and these in their turn were frugally reserved for abdominal, intracranial and intrathoracic procedures. For other operations we were content to use carbolised mackintosh aprons, boiled jaconette towels and gloved hands rescrubbed for each case. On one occasion the water consumption of a single theatre was measured. In opening the theatre, sterilising instruments, scrubbing hands and patients, performing a list of 23 consecutive major operations, applying 6 plaster cases, and closing the theatre again, the water consumption was 35 gallons, or 6 quarts per case. My surgical team carried a water reserve of 80 gallons.

Evacuation by Air

The western desert, having stated a difficult problem of evacuation, seemed to offer a solution of the problem by providing, almost ready-made, a vast number of landing-grounds for aircraft. To some extent air evacuation offered an early and speedy transport of wounded from the forward areas to the base hospitals, but it is not free from disadvantages and even dangers.

It may be stated without further reservation that, provided no stage of evacuation lasts longer than 5 hours, low-level flying below 3000 feet is safe for all wounded, except perhaps such wounds of head and chest as are in danger of a renewal of intracranial or intrathoracic hæmorrhage. Low-level flying, however, may occasion a high degree of discomfort if the course is set over an uneven desert surface, broken by ravines and ridges, and rigid immobilisation is as necessary for evacuation by air as it is for ambulance car travel by land. A further cause of discomfort is the difficulty of making lavatory arrangements

in a plane crowded with wounded men. Perhaps the gravest drawback of air evacuation is that it cannot work precisely to programme, being more dependent than surface evacuation upon local meteorological and tactical considerations. The disappointment of spending the day at a landing-ground on a stretcher and then returning at dusk to the same medical formation which he left at dawn, is very trying to a wounded man. Occasionally the disappointment may necessarily be repeated on a second day.

High-level evacuation is less uncomfortable, but more dangerous, and cases for this form of evacuation require the most careful selection. Abdominal wounds withstand height badly during their early post-operative period—any tendency to tympanites seems to be exaggerated. Head wounds travel well at high altitudes provided there is no risk of intracranial hæmorrhage or tension. Men recently resuscitated from profound shock do not travel well at high levels, nor do cases where hæmorrhage continues, even in small amount, during evacuation. Chest wounds travel badly after operation, in the air as on the road or by rail ; intrathoracic hæmorrhage seems to be easily precipitated, and post-operative empyemas in particular require great care in the fixation of drainage tubes. Indeed, the chest case, like the abdominal case, should be held for many days after operation in the place where the operation has been performed.

It may be that in the future air transport will be employed largely for the evacuation of the sick and lightly wounded and of cases for pre-operative despatch to special centres—facio-maxillary, thoracic, and neurosurgical—as a means, in fact, of relieving pressure on the forward accommodation available for retention, after operation, of the seriously wounded.

The Discipline of Military Surgery

If equipment and surgical methods require preparation before a campaign, so also does the habit of mind of the surgeon. There is a fashion now to place a premium upon leisureliness in operative surgery. The surgeons of the casualty clearing stations in the last war were, many of them, craftsmen of great brilliance, and the apparent rapidity of their operating was the product of dexterity, gentleness, and single-minded concentration upon methodical sequence. Some of their imitators appreciated and emulated their speed alone. To-day, however, the pendulum has swung in the opposite direction, and speed has been so much condemned that its sister virtues—dexterity of hand, economy of movement and discipline of method—are less consciously cultivated than they used to be.

A few minutes more or less of anæsthesia are perhaps unimportant, but hours spent in unnecessary repetition of manœuvre, in aimless manipulation, in unproductive speculation, and in postponement or tardiness of decision, are a menace to the life and health of the patient

on the table, and a dangerous cause of delay in the treatment of the unfortunates who are awaiting their turn for operation. The danger of exposing hot and steaming viscera or muscles for a period of several hours to a cold, dry and dust-laden desert air should be sufficiently obvious, but even if it were not, the surgeon should remember that his time is not his own to waste—it is the precious property of the wounded men in his pre-operative ward. Reasonable unhurrying speed is a valuable virtue in the forward surgeon, but it cannot be acquired by operating to the clock. Economy of time requires thrift of movement, but a generous expenditure of thought. The military surgeon's every moment must be spent in observation, deduction and planning. Self-discipline must be rigid and regardless of fatigue in the clinical study of the patient and the planning of procedure before operation, in single-minded adhesion to a standard sequence once the operation begins, in accuracy of observation, unfaltering logic of judgment, and steadfast determination of decision during the course of the operation, and in ruthless self-criticism of every step when the operation is over. Such discipline will bring a reasonable rapidity in its train, and the wounded at the end of the list will gain by it. Speed as a fetish is dead, but let us aspire still to the higher surgical attributes and a sufficient speed will be added to them.

ACKNOWLEDGMENT

Figs. 3, 4, 5, 6 and 7 were kindly provided by Captain G. C. Dorset, R.I.A.S.C.

ROYAL COLLEGE OF SURGEONS OF ENGLAND

W. H. COLLINS PROFESSORSHIP OF HUMAN AND COMPARATIVE PATHOLOGY

The Council of the Royal College of Surgeons of England invites applications for the W. H. Collins Professorship of Human and Comparative Pathology.

The salary will be £2000 per annum.

The principal duty of the professor will be the care and demonstration of the pathological collections. He will also be expected to promote the advancement of knowledge of the diseases of man and animals by original investigation, and by instruction in the methods of research. At this juncture the main requirement of the College is the restoration and reorganisation of its Museum. For this work suitable assistance will be provided. The election is an open one, but the Council reserves the right to invite individual applications.

Particulars and terms of appointment may be obtained from the Secretary. Applications, with the names of two references, must reach the College not later than 31st July 1944.

KENNEDY CASSELS
Secretary

LINCOLN'S INN FIELDS
LONDON, W.C.2